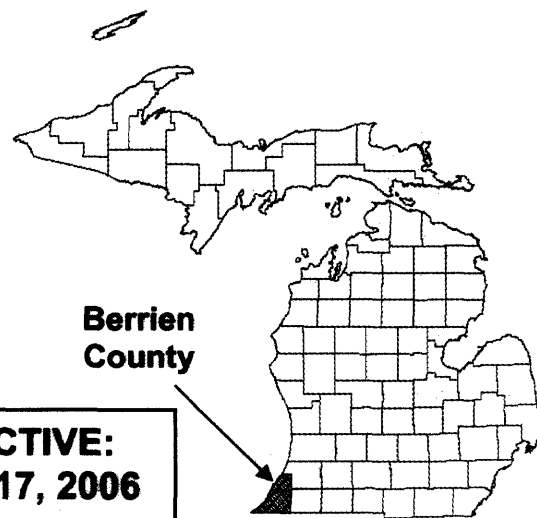


FLOOD INSURANCE STUDY



BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER
* BAINBRIDGE, TOWNSHIP OF	261103
* BARODA, TOWNSHIP OF	261106
* BARODA, VILLAGE OF	261105
BENTON, TOWNSHIP OF	260031
BENTON HARBOR, CITY OF	260032
BERRIEN SPRINGS, VILLAGE OF	260330
BERRIEN, TOWNSHIP OF	260733
BERTRAND, TOWNSHIP OF	261109
BRIDGMAN, CITY OF	260033
BUCHANAN, CITY OF	260554
BUCHANAN, TOWNSHIP OF	260555
CHIKAMING, TOWNSHIP OF	260258
COLOMA, CITY OF	260556
COLOMA, TOWNSHIP OF	260034
* EAU CLAIRE, VILLAGE OF	260999
GALIEN, TOWNSHIP OF	261108
* GALIEN, VILLAGE OF	261107
GRAND BEACH, VILLAGE OF	260268
HAGER, TOWNSHIP OF	260035
LAKE, TOWNSHIP OF	260036
LINCOLN, TOWNSHIP OF	260037
MICHIANA, VILLAGE OF	260275
NEW BUFFALO, CITY OF	260038
NEW BUFFALO, TOWNSHIP OF	260039
NILES, CITY OF	260040
NILES, TOWNSHIP OF	260041
ORONOKO, TOWNSHIP OF	260042
PIPESTONE, TOWNSHIP OF	261104



COMMUNITY NAME	COMMUNITY NUMBER
ROYALTON, TOWNSHIP OF	260043
ST. JOSEPH, CITY OF	260044
ST. JOSEPH, TOWNSHIP OF	260045
SHOREHAM, VILLAGE OF	260280
SODUS, TOWNSHIP OF	260046
STEVENSVILLE, VILLAGE OF	260557
THREE OAKS, TOWNSHIP OF	261111
* THREE OAKS, VILLAGE OF	261110
WATERVLIET, CITY OF	260047
WATERVLIET, TOWNSHIP OF	260048
WEESAW, TOWNSHIP OF	260049

* NON FLOOD PRONE



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

26021CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. It is advisable to contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

<u>Old Zones</u>	<u>New Zone</u>
A1 through A30	AE
B	X (shaded)
C	X

Countywide FIS Effective Date: April 17, 2006

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PUBLISHED SEPARATELY

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Flood Insurance Rate Maps	

FLOOD INSURANCE STUDY
BERRIEN COUNTY, MICHIGAN

1.0 INTRODUCTION

1.1 Purpose of Study

This 2006 Flood Insurance Study (FIS) revises and supersedes the FIS reports, Flood Insurance Rate Maps (FIRMs) and/or Flood Boundary and Floodway Maps (FBFMs) in the geographic area of Berrien County, including the Cities of Benton Harbor, Bridgman, Buchanan, Coloma, New Buffalo, Niles, St. Joseph and Watervliet; the Townships of Bainbridge, Baroda, Benton, Berrien, Bertrand, Buchanan, Chikaming, Coloma, Galien, Hager, Lake, Lincoln, New Buffalo, Niles, Oronoko, Pipestone, Royalton, St. Joseph, Sodus, Three Oaks, Watervliet, and Weesaw; the Villages of Baroda, Berrien Springs, Eau Claire, Galien, Grand Beach, Michiana, Shoreham, Stevensville, and Three Oaks and unincorporated areas of Berrien County (hereinafter referred to collectively as Berrien County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Please note that the Townships of Bainbridge and Baroda and Villages of Baroda, Eau Claire, Galien, and Three Oaks are Non-Flood Prone. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR. 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

The Digital Flood Insurance Rate Map (DFIRM) and FIS Report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the FEMA DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

1.2 Authority and Acknowledgements

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

Information on the authority and acknowledgments for each of the previously printed FISs and Flood Insurance Rate Maps (FIRMs) for communities within Berrien County was compiled, and is shown below.

Township of Benton	The hydrologic and hydraulic analyses for the June 1977 study for the Township of Benton were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in February 1977 (Reference 1).
City of Benton Harbor	The hydrologic and hydraulic analyses for the November 1977 study for the City of Benton Harbor were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in February 1977 (Reference 2).
Village of Berrien Springs	Approximate flood boundaries for St. Joseph River in the Village of Berrien Springs were completed in April 1986 (Reference 3).
Township of Berrien	Approximate flood boundaries for St. Joseph River in the Township of Berrien were completed in August 1988 (Reference 4).
City of Bridgman	The hydrologic and hydraulic analyses for the 2004 study for the City of Bridgman were performed by the Michigan Department of Environmental Quality (MDEQ) (Reference 5). The study was performed under Contract No. EMC 2003-GR-0022. The analysis for this study was completed in August 2004. This analyses supersedes the May 1979 City of Bridgman FIS (Reference 6).
City of Buchanan	The hydrologic and hydraulic analyses for the April 1993 study for the City of Buchanan were performed by the U.S. Department of Agriculture, Soil Conservation Service (SCS). The analysis for this study was completed in January 1986 (Reference 7).
Township of Buchanan	Approximate flood boundaries for Judy Lake Drain, Judy Lake, Boyle Lake, Clear Lake, Indian Lake, Madron Lake, Wagner Lake, Yellow Lake and St. Joseph River in the Township of Buchanan were completed in March 1998 (Reference 8).
Township of Chikaming	The hydrologic and hydraulic analyses for the December 1977 study for the Township of Chikaming were performed by Johnson &

	Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in March 1977 (Reference 9).
City of Coloma	Approximate flood boundaries for Paw Paw River in the City of Coloma were completed in January 1980 (Reference 10).
Township of Coloma	The hydrologic and hydraulic analyses for the August 1983 study for the Township of Coloma were performed by the U.S. Department of Agriculture, Soil Conservation Service (SCS). The analysis for this study was completed in July 1976 (Reference 11).
Village of Grand Beach	The hydrologic and hydraulic analyses for the April 1977 study for the Village of Grand Beach were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in April 1977 (Reference 12).
Township of Hager	The hydrologic and hydraulic analyses for the February 1977 study for the Township of Hager were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in October 1976 (Reference 13).
Township of Lake	The hydrologic and hydraulic analyses for the May 1979 study for the Township of Lake were performed by William & Works, Inc. for the Federal Insurance Administration, under Contract No. H-4538. The analysis for this study was completed in June 1978 (Reference 14).
Township of Lincoln	The hydrologic and hydraulic analyses for the May 1977 study for the Township of Lincoln were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in December 1976 (Reference 15).
Village of Michiana	The hydrologic and hydraulic analyses for the November 1977 study for the Village of Michiana were performed by Johnson &

	Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in December 1976 (Reference 16).
City of New Buffalo	The hydrologic and hydraulic analyses for the June 1979 study for the City of New Buffalo were performed by William & Works, Inc. for the Federal Insurance Administration, under Contract No. H-4538. The analysis for this study was completed in May 1978 (Reference 17).
Township of New Buffalo	The hydrologic and hydraulic analyses for the June 1979 study for the Township of New Buffalo were performed by William & Works, Inc. for the Federal Insurance Administration, under Contract No. H-4538. The analysis for this study was completed in May 1978 (Reference 18).
City of Niles	The hydrologic and hydraulic analyses for the July 1987 study for the City of Niles were performed by STS Consultants, Ltd. for the Federal Emergency Management Agency (FEMA) under Contract No. EMW-83-C-1169. The analysis for this study was completed in August 1985 (Reference 19).
Township of Niles	Approximate flood boundaries for Dowagiac River and St. Joseph River in the Township of Niles were completed in June 1986 (Reference 20).
Township of Oronoko	Approximate flood boundaries for St. Joseph River in the Township of Oronoko were completed in June 1986 (Reference 21).
Township of Royalton	The hydrologic and hydraulic analyses for the February 1977 study for the Township of Royalton were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in December 1976 (Reference 22).
City of St. Joseph	The hydrologic and hydraulic analyses for the December 1976 study for the City of St. Joseph were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this

	study was completed in July 1976 (Reference 23).
Township of St. Joseph	The hydrologic and hydraulic analyses for the December 1979 study for the Township of St. Joseph were performed by William & Works, Inc. for the Federal Insurance Administration, under Contract No. H-4538. The analysis for this study was completed in August 1978 (Reference 24).
Village of Shoreham	Approximate flood boundaries for Lake Michigan and Hickory Creek in the Village of Shoreham were completed in February 1982 (Reference 25).
Township of Sodus	The hydrologic and hydraulic analyses for the June 1977 study for the Township of Sodus were performed by Johnson & Anderson, Inc. for the Federal Insurance Administration, under Contract No. H-3816. The analysis for this study was completed in December 1976 (Reference 26).
Village of Stevensville	Approximate flood boundaries for Hickory Creek in the Village of Stevensville were completed in September 1975 (Reference 27).
City of Watervliet	The hydrologic and hydraulic analyses for the May 1983 study for the City of Watervliet were performed by the U.S. Department of Agriculture, Soil Conservation Service (SCS). The analysis for this study was completed in July 1976 (Reference 28).
Township of Watervliet	The hydrologic and hydraulic analyses for the May 1983 study for the Township of Watervliet were performed by the U.S. Department of Agriculture, Soil Conservation Service (SCS). The analysis for this study was completed in July 1976 (Reference 29).

Additional hydrologic analyses for this 2006 FIS were performed by the Michigan Department of Environmental Quality (MDEQ). Additional hydraulic analyses were performed by Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM) for the Federal Emergency Management Agency (FEMA) under Contract No. EMC-2001-CO-0058. This work, which was completed in September 2004, covered all significant flooding sources affecting Berrien County.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO's) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study. The dates of the initial and final CCO meetings held for prior FISs for the incorporated communities within Berrien County are shown in Table 1.

TABLE 1 – CCO Meeting Dates for Prior FISs

<u>Community Name</u>	<u>Initial CCO Date</u>	<u>Final CCO Date</u>
Benton, Township of	February 18, 1975	February 23, 1977
Benton Harbor, City of	February 18, 1975	February 23, 1977
Bridgman, City of	not published	not published
Buchanan, City of	December 13, 1991	March 30, 1992
Chikaming, Township of	February 18, 1975	May 19, 1977
Coloma, Township of	not published	October 27, 1982
Grand Beach, Village of	February 17, 1975	February 25, 1977
Hager, Township of	not published	December 6, 1976
Lake, Township of	May 31, 1977	October 16, 1978
Lincoln, Township of	not published	February 23, 1977
Michiana, Village of	February 18, 1975	December 7, 1976
New Buffalo, City of	May 31, 1977	December 12, 1978
New Buffalo, Township of	May 31, 1977	December 12, 1978
Niles, City of	April 18, 1983	August 28, 1986
Royalton, Township of	July 30, 1975	December 7, 1976
St. Joseph, City of	July 30, 1975	June 22, 1976
St. Joseph, Township of	October 21, 1977	June 19, 1979
Sodus, Township of	July 30, 1975	December 7, 1976
Watervliet, City of	not published	October 21, 1982
Watervliet, Township of	not published	October 21, 1982

For the 2006 FIS, an initial CCO meeting was held on July 28, 2003. The final CCO meeting was held on December 6, 2004. Both meetings were attended by representatives from Berrien County, MDEQ, and FEMA.

2.0 AREA STUDIED

2.1 Scope of Study

This 2006 FIS covers the geographic area of Berrien County, Michigan, including the incorporated communities listed in Section 1.1 and unincorporated areas. This study area covers approximately 43 coastal miles.

New approximate analyses were developed for areas where there is a potential for development and no floodplains currently exist.

To avoid confusion from streams that shared the same name in previous FIS reports and FIRMs, two stream names were modified for this 2006 FIS. The streams are listed in the following table.

TABLE 2 – Stream Name Changes

<u>Community</u>	<u>Old Name</u>	<u>New Name</u>
Village of Grand Beach	White Creek	White Creek – East Branch
Village of Michiana	White Creek	White Creek – West Branch
City of Niles	West Tributary	West Tributary St. Joseph River

The flooding sources studied previously by detailed methods are shown in Table 3.

TABLE 3 – Limits of Detailed Studies (from prior FIS Reports)

<u>Flooding Source</u>	<u>Limits of Detailed Study</u>
Bedortha Drain	From mouth at Tanner Creek to approximately 1100 feet north of Rambo Road (City of Bridgman)
Bridgman City Drain	From confluence with Bedortha Drain to approximately 700 feet west of Church Street (City of Bridgman)
Dowagiac River	From City of Niles western corporate limits to City of Niles northern corporate limits (City of Niles)
Galien River	From mouth at Lake Michigan to approximately 6000 feet upstream of the Red Arrow Highway Bridge (City of New Buffalo, Township of New Buffalo)
Glenlord Road Drain (North Branch)	From mouth at Glenlord Road Drain (South Branch) to approximately 800 feet north of W Glenorchard Road (Township of Lincoln)
Glenlord Road Drain (South Branch)	From mouth at Parker / Richardson Drain to approximately 500 feet east of Washington Avenue (Township of Lincoln)
Goodrow Drain	From Village of Stevensville eastern corporate limits to approximately 2500 south of W John Beers Road (Township of Lincoln)
Granger Drain	From mouth at Paw Paw River to approximately 1300 feet west of Pier Road (Township of Hager)
Granger Drain Tributary	From mouth at Granger Drain to approximately 1300 feet south of Coloma Road (Township of Hager)
Hickory Creek	From mouth at St. Joseph River to Village of Stevensville eastern corporate limits, then from Village of Stevensville southern corporate limits to approximately 2100 feet south of Johnson Road (Township of St. Joseph, Township of Lincoln)
Lake Michigan	Throughout Berrien County from Van Buren County, Michigan to Lake County, Indiana

<u>Flooding Source</u>	<u>Limits of Detailed Study</u>
McCoy Creek	From mouth at St. Joseph River to northeast intersection of Chamberlain Road and Bakertown Road (City of Buchanan)
Ox Creek	From mouth at Paw Paw River to approximately 2200 feet south of E Napier Avenue (City of Benton Harbor, Township of Benton)
Parker/Richardson Drain	From mouth at Hickory Creek to approximately 2500 feet north of W Rocky Weed Road (Township of Lincoln)
Paw Paw Lake	Located in Township of Coloma and Township of Watervliet
Paw Paw River	From mouth at St. Joseph River to N County Line Road at Berrien County / Van Buren County boundary. (City of St. Joseph, City of Benton Harbor, Township of Benton, Township of Hager, Township of Coloma, Township of Watervliet, City of Watervliet)
St. Joseph River	From mouth at Lake Michigan to approximately 1100 feet south of Hipps Hollow Road (City of St. Joseph, City of Benton Harbor, Township of St. Joseph, Township of Royalton, Township of Sodus); from approximately 600 feet east of Nature Way to approximately 1200 feet west of Bond Street (City of Niles)
Tanner Creek, William & Esseg Drain	From mouth at Lake Michigan to northern city limits adjacent to Red Arrow Highway Tanner Creek changes its name to William & Esseg Drain upstream of the Interstate Highway 94 Bridge. (City of Bridgman)
Tributary A	From mouth at Lake Michigan to approximately 400 feet north of Sawyer Road (Township of Chikaming)
Tributary B	From mouth at Lake Michigan to Red Arrow Highway (Township of Chikaming)
Tributary C	From mouth at Tributary B to approximately 650 feet south of Blackwell Drive (Chikaming Township)
West Tributary St. Joseph River	From mouth at St. Joseph River to approximately 2650 feet east of S Phillip Road (City of Niles)
White Creek – East Branch	From Ravine Road to downstream of Grand Beach Road (Village of Grand Beach)
White Creek – West Branch	From approximately 1200 feet south of Ridgeview Drive to Michiana Drive (Village of Michiana)

<u>Flooding Source</u>	<u>Limits of Detailed Study</u>
Yellow Creek	From mouth at St. Joseph River to approximately 1400 feet south of E John Beers Road (Township of Royalton)

This countywide FIS also incorporates the determination of letters issued by the Federal Emergency Management Agency (FEMA) resulting in map revisions (Letter of Map Revisions (LOMR)) and map amendments (Letter of Map Amendments (LOMA)). LOMRs and mappable LOMAs that were incorporated are shown in Table 4.

TABLE 4 – Incorporated Letters of Map Revision and Letters of Map Amendment

<u>Flooding Source</u>	<u>Community and Project Identifier</u>	<u>Date Issued</u>
St. Joseph River	City of St. Joseph T-218-65-R	May 10, 1991
St. Joseph River (Left Overbank)	Township of Royalton 92-05-078P	September 30, 1992
St. Joseph River	Township of St. Joseph 93-05-339P	January 7, 1994
Paw Paw Lake & Paw Paw River	Township of Coloma, Township of Watervliet 895010 (Regional)	July 10, 1989
St. Joseph River	Township of Benton 01-05-1461A	September 26, 2001
St. Joseph River	Township of St. Joseph 02-05-3951A	September 25, 2002
St. Joseph River	Township of St. Joseph 03-05-1428A	February 14, 2003
St. Joseph River	Township of Benton 03-05-2068A	May 2, 2003

Letters of Map Amendment (LOMA) incorporated for this study are summarized in the Summary of Map Amendment (SOMA) included in the Technical Support Data Notebook (TSDN) associated with this FIS update. Copies of the TSDN may be obtained from the Community Map Repository.

2.2 Community Description

Berrien County is located on the southwest border of Michigan. It is bordered by Van Buren County, Michigan, on both the north and northeast; Cass County, Michigan, on the southeast; Lake County, Indiana, on the south; and Lake Michigan on the west. The major transportation arteries of Berrien County include Interstates 94 and 196; State Highways 51, 60, 63, 139, 140 and 239; US

Highways 12, 31 and 33; Lake Michigan; and C&O, Penn Central and Conrail Railroads. The April 1, 2000 census population of Berrien County was reported to be 162,453. The estimated July 1, 2003 population was 162,766 (Reference 30).

The climate of Berrien County alternates between semi-marine and continental in character and is significantly influenced by the prevailing winds from the west that are cooled in summer and warmed in winter as they pass over Lake Michigan. This has the effect of moderating extreme temperatures. Temperature extremes vary from a mean monthly maximum of 73°F in July to a mean monthly minimum of 23°F in January, with a mean annual temperature of 49°F. The mean annual precipitation is approximately 35 inches and is well distributed throughout the year. The mean annual snowfall is approximately 70 inches (Reference 31).

The topography of Berrien County is relatively flat and gently sloping, with the Lake Michigan shoreline being marked by a line of steep bluffs which rise approximately 40 feet above the lake level. The largest rivers in the county are St. Joseph River, Paw Paw River and Galien River, all of which drain to Lake Michigan.

The predominant soil groupings in the county vary from well-drained sands along the Lake Michigan shoreline to somewhat poorly to moderately well-drained loams throughout the remainder of the county.

2.3 Principal Flood Problems

Flooding throughout the county results from overflow of streams caused by heavy rainfall or by a combination of rainfall and snowmelt. Additionally, ice jams have been known to cause flooding. A revised and updated study for the City of Bridgman was completed by MDEQ in 2004 due to increased flooding problems. Ox Creek, St. Joseph River and Paw Paw River have historically caused the most damage when flooding. In addition, historical high water events have been recorded due to flooding from Lake Michigan.

City of Bridgman

In the 1980s, Lake Street had experienced flooding problems from Tanner Creek. The restrictive culvert has been replaced, and since that time the City and residents could not recall any flooding problems. Also in the 1980's, high-water was observed on Bedortha Drain upstream of Red Arrow Highway (Reference 5).

Shoreline erosion is a serious problem in the community. The shoreline area affected by Lake Michigan flood levels is characterized by steep bluffs. The flood levels of Lake Michigan would not contribute directly to property damage but could accelerate shoreline erosion (Reference 5).

Lake Michigan

A listing of high water levels for Lake Michigan as recorded at the Calumet Harbor, Indiana gage is presented in the following table. The gage, which is approximately 50 miles southwest of Berrien County, is the National Oceanic and Atmospheric Administration (NOAA) master gage for southern Lake

Michigan and is representative of the lake levels of Berrien County. The records for the Calumet Harbor gage cover from 1903 to the present. The period from 1972 through 1974 represents the longest sustained period of high water levels recorded at the Calumet Harbor gage.

TABLE 5 – Historical High Water Events & USACE Lake Michigan Open-Coast Flood Levels

<u>Year</u>	<u>Lake Michigan Elevation Feet (NGVD 1929*)</u>
July 19, 1970	582.1
July 23, 1971	584.6
November 14, 1972	583.4
April 25, 1973	583.3
June 17, 1973	583.2
May 16, 1973	583.2
February 22, 1974	583.5
June 22, 1974	583.1
Predicted 10-Percent-Annual-Chance Lake Level	583.5
Predicted 2-Percent-Annual-Chance Lake Level	584.6
Predicted 1-Percent-Annual-Chance Lake Level	585.0
Predicted 0.2-Percent-Annual-Chance Lake Level	585.9

* National Geodetic Vertical Datum of 1929

The July 23, 1971 event is the flood of record at the Calumet gage. The previous flood of record at Calumet Harbor was 584.5 feet on October 25, 1929 (Reference 34). The predicted, open-coast flood levels listed in the above table were developed by the USACE, and were recorded in the 1988 revised report on open-coast flood levels (Reference 35).

Five USGS gages are located within Berrien County to record peak streamflows on the Galien River, St. Joseph River and Paw Paw River (Reference 36).

Lake Michigan shoreline erosion is a problem in the Cities of New Buffalo and St. Joseph, in the Townships of Benton, Chikaming, Lake, Lincoln and New Buffalo, and in the Villages of Grand Beach and Michiana (References 1, 9, 12, 14, 15, 16, 17, 18, 23). This problem is accentuated during periods of high lake levels.

Ox Creek

Major floods occurred on Ox Creek in 1937 and 1943. Major flooding occurred again in April 1947, inundating several streets in the downtown area of Benton Harbor. In 1949 and 1950, Ox Creek was widened and deepened from its confluence with the Paw Paw River upstream to North Shore Drive. However, in 1950, major flooding occurred again, inundating streets and flooding several buildings in downtown Benton Harbor. In the period from 1950 to 1952, numerous improvements were made in the Ox Creek channel and most of the

culverts were enlarged. Since that time, there has been no serious flooding on Ox Creek. The following table was developed for a comparison of high water events and flooding in the City of Benton Harbor for Ox Creek (Reference 2).

TABLE 6 – Historical High Water Events on Ox Creek

<u>Event</u>	Approximate River Elevation (Feet NGVD) *	
	<u>North Shore Drive</u>	<u>Main Street</u>
Street Centerline – Elevation at Culvert	586.8	588.8
March 31, 1949	581.1	586.4
December 22, 1949	579.6	584.4
April 4, 1950	580.7	583.7
April 24, 1950	584.0	588.8
April 25, 1950	581.8	585.7
Predicted 10-Percent-Annual-Chance	583.0	585.6
Predicted 2-Percent-Annual-Chance	584.6	588.0
Predicted 1-Percent-Annual-Chance	585.3	588.8
Predicted 0.2-Percent-Annual-Chance	587.0	590.0

* National Geodetic Vertical Datum of 1929

Paw Paw River

A major flood occurred on the Paw Paw River in April 1947 when about 5.1 inches of rainfall was recorded in both Benton Harbor and Paw Paw River basins (References 28 and 29). The U.S. Geological Survey (USGS) determined the peak discharge to be approximately 4,800 cubic feet per second. Major property damage occurred around Paw Paw Lake and in Benton Harbor.

The following table was developed for comparison of high water events and flood flows on the Paw Paw River. The information applies to the vicinity of the Riverside, Michigan, gaging station, near the Coloma Road Bridge. The high water level on January 4, 1973, was caused by ice (Reference 13).

TABLE 7 – Historical High Water Events on Paw Paw River

<u>Event</u>	<u>Estimated Flow (CFS)</u>	<u>Approximate River Elevation (Feet NGVD) *</u>
January 23, 1952	1650	597.5
February 6, 1968	2140	598.1
January 4, 1973	2100	598.3
Predicted 10-Percent-Annual-Chance	2172	598.2
Predicted 2-Percent-Annual-Chance	3500	599.9
Predicted 1-Percent-Annual-Chance	4100	600.5
Predicted 0.2-Percent-Annual-Chance	7000	603.0

* National Geodetic Vertical Datum of 1929

Ice jams have occurred on Paw Paw River, with possibly the worst case occurring in January 1969, which caused high water in the City of Benton Harbor. It also caused flooding in the northwestern areas of Township of Benton along the river (Reference 1).

This storm raised the level of Paw Paw Lake to 627.10 feet NGVD, which is 6.13 above the lowest level of record occurring on April 15, 1941. Lake levels of 627.10 feet elevation caused flooding of the foundations of 84 cottages, interfered with septic tank operation, and subjected wells to the possibility of pollution.

Other major floods which caused property damage in the general area occurred in 1943 and 1950. Large storm events occurred in the watershed in 1895, 1914, 1918, 1941, 1975, 1986 and 1997.

St. Joseph River

Flooding has occurred several times on the St. Joseph River. A U.S. Army Corps of Engineers' (USACE) report states that major floods occurred in 1876, 1887, 1892, 1903 and 1904 (Reference 32). In addition to these floods, the USACE Survey Report on Flood Control states that major floods also occurred in 1908, 1937, 1943, 1947 and 1950 (Reference 33). The maximum flow of the April 4, 1950 flood was approximately 20,560 cubic feet per second.

Ice jams on the St. Joseph River have caused flooding two or three times in the past century. A destructive jam occurred in the 1930s at the Michigan Central Railroad Bridge. This structure was removed in 1975 (References 2, 23). In the Township of Sodus, the 1950 flood caused a washout on River Road that swept approximately 20 feet of pavement over the sheer river bluff. Rushing water from nearby fields cut a gully ranging from 25 to 30 feet in depth through the roadway at this location (Reference 26).

Other factors contributing to the flooding of the St. Joseph River are rainfall and rainfall in combination with spring snowmelt. Also, approximately 3.3 miles of the St. Joseph River are under the influence of Lake Michigan flood elevations (Reference 23).

In the Township of Royalton, flooding from the St. Joseph River and Yellow Creek in 1950 washed out Highway 139 at a point 0.5 mile south of Somerlayton Bridge over St. Joseph River. In March 1976, properties were flooded along Linden and Derfla Drives in the northern portion of the township (Reference 22).

A relatively recent historical high-water mark for the St. Joseph River was recorded in March 1982 in the City of Niles. The flood was estimated to have a recurrence interval of less than 50 years. Damages caused by the flood event included inundation of over 25 residences, several businesses, the hospital, and the wastewater treatment plant in Niles (Reference 19).

The following table was developed for comparison of high water events and flooding on the St. Joseph River (References 1, 23):

TABLE 8 – Historical High Water Events on St. Joseph River

<u>Event</u>	Estimated Flow (CFS)	Approximate River Elevation (Feet NGVD)*		
		<u>Main Street</u>	<u>Interstate 94 Bridge</u>	<u>U.S. Highway 131 Bridge</u>
April 4, 1950	-	580.1	-	-
April 5, 1950	21,130	-	591.7	592.4
June 17, 1973	-	583.2	-	-
June 22, 1974	-	583.1	-	-
March 6, 1976	16,056		587.1	588.2
Predicted 10- Percent-Annual- Chance	17,490	583.0	587.6	588.0
Predicted 2- Percent-Annual- Chance	21,510	-	588.6	578.2
Predicted 1- Percent-Annual- Chance	23,190	584.3	589.0	589.6
Predicted 0.2- Percent-Annual- Chance	27,160	-	589.9	590.6

* National Geodetic Vertical Datum of 1929

There are no known principal flood problems in the Townships of Bainbridge or Baroda, or in the Villages of Baroda, Eau Claire, Galien, or Three Oaks.

2.4 Flood Protection Measures

Approximately 31 dams are located in Berrien County that help attenuate flood peaks. These include the French Paper Company Dam on the St. Joseph River in

the City of Niles and the Paw Paw Lake Level Control Structure on Paw Paw River in Township of Watervliet.

In the City of Niles, the French Paper Company Dam is located on the St. Joseph River about 1,600 feet downstream of the confluence of West Tributary St. Joseph River. Built in 1914, the dam consists of a 320-foot long concrete spillway with timber flashboards and connecting earth embankments. Crest elevation with the boards up is 653.75 feet (NGVD) and with the boards down is 651.48 feet (NGVD). The boards are in place from June through December, providing approximately 14 feet of head for power generation at the French Paper Company Powerhouse, located 170 feet downstream from the spillway. Although the primary purpose of the dam appears to be power generation, the structure also serves to attenuate flood peaks through storage in the upstream channel (Reference 19).

The Cities of Benton Harbor and St. Joseph participated in Operation Foresight, sponsored by the U.S. Army Corps of Engineers. In Benton Harbor, the temporary flood protection measures constructed under the program were installed on the north side of Graham Street, west of the Paw Paw River, and west of Riverview Drive, on the drainage canal north of Main Street in Benton Harbor (Reference 2). In St. Joseph, temporary flood protection measures were constructed on the northern shore of the ship turning basin on the St. Joseph River, between US Highway 33 and the Chesapeake and Ohio Railroad Bridge; around the marina complex on the St. Joseph River shore of Radio Island; around the Shell Oil Corporation yard office on Radio Island; and, around the office building and transmitter of Radio Station WSJM on Radio Island (Reference 23).

Various shoreline erosion protection measures have been undertaken by shoreline property owners in an effort to prevent further erosion. Although these protective measures are permanent, they do not reduce flood hazards (References 1, 15, 16, 17). The flood protection measures consisted of rock-mastic revetments in the Village of Michiana (Reference 16).

No community flood protection measures presently exist and none are planned in the foreseeable future for the Cities of Benton Harbor, Bridgman, Buchanan, and New Buffalo, and the Townships of Benton, Chikaming, Coloma, Hager, Lake, Lincoln, New Buffalo, Royalton, St. Joseph, Sodus, and Watervliet, and the Village of Grand Beach (References 1, 2, 5, 7, 9, 11, 12, 13, 14, 15, 17, 18, 22, 24, 26, 29). No flood measures are known or for other remaining communities in Berrien County.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100- or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100- and 500-year floods, have a 10-, 2-, 1- and 0.2-percent chance, respectively, of being equaled

or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

This section is a compilation of previously published hydrologic information from earlier FIS reports where streams were studied in detail. New hydrology for the City of Bridgman is also reported.

City of Bridgman

New detailed hydrologic analyses were completed by MDEQ and reported in the City of Bridgman 2004 FIS (Reference 5). Bedortha Drain, Bridgman City Drain, Tanner Creek and William & Esseg Drain were all restudied. The peak discharge-frequency relationships were developed using the Soil Conservation Service (SCS) methodology, which has been adapted to Michigan (Reference 37). The methodology uses drainage area, precipitation, time of concentration, soils types, and land use to determine runoff hydrographs. The runoff hydrograph computations were performed using USACE's HEC-HMS computer software (Reference 38).

The precipitation values for the 10-, 2-, and 1-percent-annual-chance rainfall events were taken from Bulletin 71 (Reference 39), the 0.2-percent-annual-chance event was extrapolated from the values in the report.

The drainage areas were determined from a digital USGS 7.5 minute topographic quadrangle map (Reference 40). The runoff curve numbers were generated using existing digital land use values updated by field investigation and existing digital soil survey information (Reference 41). ArcView (Reference 42) was used to generate runoff curve numbers and compute the drainage areas.

Reservoir routings were done at several restrictive crossings to account for the attenuation of flood flows.

The previous FIS included a reservoir routing in the upper portions of Tanner Creek and William & Esseg Drain. Since the restrictive culvert has been removed, the current analysis does not include a routing at this location.

Paw Paw River

For Paw Paw River, peak discharge-frequency relationships were developed by the Soil Conservation Service (SCS) using the SCS's Technical Release No. 20

Computer Program (Reference 43). The SCS compared the results of the computer flood routings with those obtained from analysis of the USGS gage at Riverside, MI (04102500). The records from the gage were analyzed by the SCS using log-Pearson Type III distribution frequency analysis. (This detailed method of study for Paw Paw River, summarized above, was performed for and described in the following FISs: City of Benton Harbor 1977 FIS, Township of Coloma 1977 FIS, Township of Hager 1977 FIS, City of St. Joseph 1976 FIS, City of Watervliet 1983 FIS, Township of Watervliet 1983 FIS).

St. Joseph River

For the St. Joseph River, floodflow-frequency data were based on the statistical analysis of stage-discharge records from two USGS gages: Niles, MI (04101500) and Berrien Springs (04102000). (The City of Niles 1987 FIS used only the records from the Niles, MI gage.) Missing data from the Berrien Springs gage records were filled in by correlation analysis with the Niles, MI gage and a USGS gage in Elkhart, IN (04100500). The statistical analysis followed the standard log-Pearson Type III method. Peak flows for the St. Joseph River at Benton Harbor were computed using the equation:

$$Q_s = Q_g \left(\frac{A_s}{A_g} \right)^a$$

Where Q_s = Flow at site
 Q_g = Flow at gage
 A_s = Drainage area at site
 A_g = Drainage area at gage
 A = An exponent

A unique value of “a” was determined for each studied flow from the relationship between corresponding peak flows at Niles and Berrien Springs. (This detailed method of study for St. Joseph River, summarized above, was performed for and described in the following FISs: City of Benton Harbor 1977 FIS, City of Niles 1987 FIS, Township of Royalton 1977 FIS, City of St. Joseph 1976 FIS, Township of St. Joseph 1979 FIS, Township of Sodus 1977 FIS).

Discharge-frequency analyses were also performed using a method based on a study of the drainage areas utilizing the SCS’s TR-20 hydrology computer program in conjunction with the techniques outlined in SCS’s National Engineering Handbook and SCS’s Technical Release No. 55 (TR-55) (References 44 and 45). This approach considers the following factors: the imperviousness of the drainage basin with regard to the effects of urbanization and soil types, vegetative cover of the drainage basin, slope of the terrain, general channel shape and slope, and rainfall distribution. Urbanization and channel conditions considered in the analyses were for existing conditions. Streams studied by this method include Galien River, Granger Drain, Granger Drain Tributary, Hickory Creek, McCoy Creek, Ox Creek, Tributaries A, B and C in Township of Chikaming, West Tributary, White Creek and Yellow Creek. (Frequency-discharge curves were published for several streams; St. Joseph River in Township of Royalton 1977 FIS, City of St. Joseph 1976 FIS and Township of Sodus 1977 FIS; Paw Paw River in City of St. Joseph 1976 FIS; White Creek in Village of Michiana 1977 FIS; and Yellow Creek in Township

of Royalton 1977 FIS. The discharges and drainage areas were interpreted from the curves and are included in Table 6.)

For the Dowagiac River in City of Niles, flood discharge was estimated based on the transportation of discharge-frequency data from the USGS Sumnerville, MI gage in Cass County (04101800), located upstream of the study area, to the northern corporate limit of the City of Niles. In this method, a proportional ratio of the respective drainage areas was used. The statistical analysis of the recorded flows at the Sumnerville gage was performed by the Michigan Department of Natural Resources (MDNR) in Water Investigations Report 84-4207 (Reference 46).

Peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods of each flooding source studied in detail are shown in Table 6.

TABLE 9 – Summary of Discharges for Detailed Riverine Studies

<u>Flooding Source & Location</u>	<u>DA (mi²)</u>	<u>10% Annual Chance Event</u>	<u>2% Annual Chance Event</u>	<u>1% Annual Chance Event</u>	<u>0.2% Annual Chance Event</u>
Bedortha Drain					
At confluence with William & Esseg Drain	1.68	110	140	160	240
u/s of Red Arrow Highway	1.59	130	210	250	350
u/s of Bridgman City Drain	0.59	80	120	140	190
d/s of Railroad	0.32	60	90	100	140
u/s of Railroad	0.24	90	170	220	320
Bridgman City Drain					
At confluence with Bedortha Drain	0.72	60	100	120	170
Railroad crossing outflow	0.46	30	47	50	53
u/s Railroad crossing	0.46	50	120	160	250
Dowagiac River					
At Confluence with St. Joseph River	288	1,270	1,490	1,580	1,800
Galien River					
Confluence with Lake Michigan	170.2	3,714	5,364	5,836	6,551
Red Arrow Highway Bridge	167.9	3,879	5,554	6,034	6,767
Glenlord Road Drain (North Branch)					

<u>Flooding Source & Location</u>	<u>DA (mi²)</u>	<u>10% Annual Chance Event</u>	<u>2% Annual Chance Event</u>	<u>1% Annual Chance Event</u>	<u>0.2% Annual Chance Event</u>
At Confluence With Glenlord Road Drain (South Branch)	0.74	42	90	105	145
Glenlord Road	0.29	25	50	58	71
Washington Avenue	0.09	13	23	27	36
Glenlord Road Drain (South Branch)					
At Confluence with Parker/Richardson Drain	1.48	105	180	205	265
Upstream of Confluence with Glenlord Road Drain (North Branch)	0.68	80	130	155	200
Washington Avenue	0.55	74	125	145	190
Goodrow Drain					
At Confluence With Hickory Creek	0.75	53	90	105	130
485 Feet Upstream of Echo Ridge Road	0.50	41	74	87	115
1400 Feet Upstream of Ponderosa Drive	0.17	18	33	40	53
Granger Drain					
Upstream of Confluence with Paw Paw River	2.72	98	135	140	155
Downstream of Confluence with Granger Drain Tributary	2.22	100	130	135	150
Upstream of Confluence with Granger Drain Tributary	1.32	67	85	89	98
C&O Railroad (Inflow)	1.12	68	125	150	195
C&O Railroad (Outflow)	1.12	62	76	79	85
1350 Feet Upstream of Pier Road	0.94	64	115	135	175
Coloma Road	0.38	39	66	75	95
Granger Drain Tributary					
Upstream of Confluence with Granger Drain	0.90	38	46	48	52
C&O Railroad (Inflow)	0.75	68	105	115	140
C&O Railroad (Outflow)	0.75	35	41	43	46
Coloma Road	0.53	46	61	63	66
Hickory Creek					

<u>Flooding Source & Location</u>	<u>DA (mi²)</u>	<u>10% Annual Chance Event</u>	<u>2% Annual Chance Event</u>	<u>1% Annual Chance Event</u>	<u>0.2% Annual Chance Event</u>
Just Upstream of Confluence With St. Joseph River	51.5	1,438	2,334	2,678	3,416
Township of St. Joseph Southern Corporate Limit	47.4	1,420	2,265	2,588	3,280
Maiden Lane	46.22	1,430	2,265	2,585	3,275
I-94	44.97	1,440	2,270	2,585	3,265
Marquette Woods Road	36.60	1,190	1,870	2,130	2,680
John Beers Road	35.14	1,200	1,865	2,120	2,665
Rocky Weed Road	34.22	1,200	1,875	2,130	2,675
McCoy Creek					
At the Confluence with St. Joseph River	18.25	505	825	950	1,290
Upstream of the Schirmer Parkway	13.45	410	670	780	1,065
At McCoy-Mill Race Junction	11.67	350	570	665	915
At Bakerstown Road	10.82	325	535	620	855
Ox Creek					
Confluence with Paw Paw River	13.52	460	800	920	1,220
Britain Avenue	11.81	400	730	855	1,145
400 feet downstream of Napier Avenue	6.55	230	415	490	655
Parker/Richardson Drain					
At Confluence with Hickory Creek	7.26	380	630	725	890
Upstream of Confluence with Glenlord Road Drain (South Branch)	5.37	275	420	475	585
1300 Feet Upstream of Marquette Woods Road	4.42	240	370	415	515
1300 Feet Downstream of Cleveland Avenue	0.61	56	97	110	125
Cleveland Avenue	0.37	44	78	92	120
Paw Paw River					
Mouth at St. Joseph River	437	2,560	4,200	4,880	7,930
St. Joseph River					
Benton Harbor	4,230	17,630	21,620	23,280	27,240
Township of Benton	4,182	17,490	21,510	23,190	27,160

<u>Flooding Source & Location</u>	<u>DA (mi²)</u>	<u>10% Annual Chance Event</u>	<u>2% Annual Chance Event</u>	<u>1% Annual Chance Event</u>	<u>0.2% Annual Chance Event</u>
At Township of St. Joseph Eastern Corporate Limit	4,150	17,490	21,510	23,190	27,160
Upstream of Confluence with Dowagiac River	3,666	15,700	20,200	22,000	26,400
Tanner Creek					
Mouth at Lake Michigan	2.93	180	300	360	510
Downstream of Bedortha Drain	2.66	170	290	340	460
Tributary A					
Mouth	1.70	110	190	220	295
400 Feet Downstream of Ravenswood Avenue	1.25	100	170	195	255
200 Feet Downstream of Sawyer Road	0.97	89	125	140	175
Tributary B					
Mouth	2.46	87	150	170	215
Confluence with Tributary C	1.83	65	105	120	140
Prairie Road	1.65	62	100	110	130
Chessie System	1.29	57	90	98	110
Tributary C					
Confluence with Tributary B	0.58	23	47	56	79
West Tributary					
At Confluence with St. Joseph River	2.6	210	340	400	500
White Creek – East Branch					
At Township of New Buffalo Corporate Limits	1.65	20	45	55	85
Red Arrow Highway	0.97	20	40	50	70
White Creek – West Branch					
Frequency-Discharge Curve (Village of Michiana 1977 FIS)	9.0	280	510	600	800
William & Esseg Drain					
Upstream of Bedortha Drain	0.98	70	140	180	270
State Police Post Driveway	0.59	30	70	90	140
Yellow Creek					

<u>Flooding Source & Location</u>	<u>DA (mi²)</u>	<u>10% Annual Chance Event</u>	<u>2% Annual Chance Event</u>	<u>1% Annual Chance Event</u>	<u>0.2% Annual Chance Event</u>
Frequency-Discharge Curve (Township of Royalton 1977 FIS)	14.5	625	1100	1300	1750
Frequency-Discharge Curve (Township of Royalton 1977 FIS)	8.3	220	390	450	625

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

This section is a compilation of hydraulic information from previously published FIS reports where streams were studied in detail. Updated hydraulic data for the City of Bridgman is also reported. New open-coast flood levels for Lake Michigan and Paw Paw Lake are also provided.

Detail-studied streams that were not re-studied as part of this map update may include a "profile base line" on the maps. This "profile base line" provides a link to the flood profiles included in the Flood Insurance Study report. The detail-studied stream centerline may have been digitized or redelineated as part of this revision. The "profile base lines" for these streams were based on the best available data at the time of their study and are depicted as they were on the previous FIRMs. In some cases where improved topographic data was used to redelineate floodplain boundaries, the "profile base line" may deviate significantly from the channel centerline or may be outside the SFHA.

City of Bridgman

The existing hydraulic support data for the City of Bridgman was spot checked in the field and used as appropriate. At several locations, new stream crossings had been constructed, and minor stream alterations had been made. The analysis incorporated the new structures and stream configuration.

The channel and overbank distances between cross sections shown in the original hydraulic support data were used, with adjustments made to account for new stream crossings.

The flood profiles for Tanner Creek and William & Esseg Drain were started with a boundary condition of 581.3 feet, NGVD 1929, the mean lake level of Lake Michigan.

Tanner Creek and William & Esseg Drain, the Bridgman City Drain, and Bedortha Drain all experience peak flows at similar times. The starting water surface elevation for Bedortha Drain has been taken to be the corresponding flood elevation for Tanner Creek and William & Esseg at the confluence with Bedortha Drain.

The starting water surface elevation for Bridgman City Drain corresponds to the flood elevation for Bedortha Drain at the confluence with the Bridgman City Drain.

Contraction and expansion coefficients (Reference 47) of 0.1 and 0.3, respectively were used for smooth transitions. In the vicinity of the bridges, these values were increased to 0.3 and 0.5 respectively.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Lake Michigan

For Lake Michigan, values for the 1- and 0.2-percent-annual-chance open-coast flood levels were found in the USACE's 1988 revised report on open-coast flood levels for the Calumet Harbor, Illinois gage station (Reference 35).

Open-coast flood levels derived for Lake Michigan from the 1988 report for Calumet Harbor are shown in Table 7. Additionally, flood levels for Paw Paw Lake from the Township of Watervliet 1983 FIS and Township of Coloma 1983 FIS are shown in the table. However, a 1983 USACE report for Paw Paw Lake supersedes the 1-percent-annual-chance flood level (Reference 48).

Approximately five feet may be added to Lake Michigan flood levels to account for wave runup. This value assumes uniformly sloped beaches subject to direct wave attach from the west. Factors such as location and shoreline configuration could alter this estimated wave runup and value. When methodology on wave runup determination is resolved, additional shoreline flood hazard areas may be delineated by FEMA.

TABLE 10 – Summary of Base Flood Elevations (NGVD)

<u>Flooding Source</u>	<u>10% Annual Chance</u>	<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.2% Annual Chance</u>
Lake Michigan (south of St. Joseph River)	583.5	584.6	585.0	585.9
Lake Michigan (north of St. Joseph River)	583.3	584.4	584.8	585.7
Paw Paw Lake	626.9	628.6	623.6	631.0

For the detailed riverine studies, analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source.

Cross sections of the detailed study reaches were all obtained by field surveys, and may have been aided by the use of USGS topographic and soil survey maps, aerial photographs and on-site field inspections. Water surface elevations of floods for the selected recurrence intervals for the streams studied in detail were computed through use of USACE's HEC-2 step-backwater computer program, and SCS's (now NRCS) WSP2 computer program (References 49 and 50). Lake elevations for Paw Paw Lake were computed with the used of flood routing and rating curves. Water surface elevations for Bedortha Drain, Bridgman City Drain and Tanner Creek were computed using HEC-RAS.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments where a floodway was computed (Section 4.2), selected cross sections locations are also shown on the FIRM (Exhibit 2).

Channel roughness coefficients (Manning's "n" values) used in the hydraulic computations were chosen by engineering judgment and are based on field observations. Roughness factors used in the detailed studies are summarized in Table 8.

TABLE 11 – Manning's "n" Values

<u>FIS</u>	<u>Flooding Source</u>	<u>Channel "n"</u> <u>Values</u>	<u>Overbank "n"</u> <u>Values</u>
Benton, Township of	Ox Creek	0.040 – 0.100	0.035 – 0.100
	Paw Paw River	0.05	0.060 – 0.150
	St. Joseph River	0.032 – 0.037	0.050 – 0.125
Benton Harbor, City of	Ox Creek	0.040 – 0.045	0.035 – 0.100
	Paw Paw River	0.050	0.060 – 0.150
	St. Joseph River	0.030 – 0.032	0.032 – 0.060
Bridgman, City of	Bedortha Drain	0.04	0.07
	Bridgman City Drain	0.055	0.07 – 0.08
	Tanner Creek	0.035 – 0.055	0.04 – 0.09
	Willam & Esseg Drain	0.035 – 0.055	0.04 – 0.09
Buchanan, City of	McCoy Creek	not published	not published
Chikaming, Township of	Tributary A	0.025 – 0.055	0.030 – 0.100
	Tributary B	0.025 – 0.055	0.030 – 0.100
	Tributary C	0.025 – 0.055	0.030 – 0.100
Coloma, Township of	Paw Paw River	not published	not published
Hager, Township of	Granger Drain	0.04 – 0.06	0.07 – 0.15
	Granger Drain Tributary	0.04 – 0.06	0.07 – 0.15

<u>FIS</u>	<u>Flooding Source</u>	<u>Channel “n” Values</u>	<u>Overbank “n” Values</u>
Grand Beach, Village of Lincoln Township	Paw Paw River	0.05	0.15
	White Creek	0.04 – 0.06	0.07 – 0.08
	Hickory Creek	0.045	0.070 – 0.090
	Glenlord Road Drain	0.032 – 0.065	0.035 – 0.080
	Goodrow Drain	0.045 – 0.055	0.035 – 0.070
	Parker/Richardson Drain	0.035 – 0.055	0.040 – 0.080
Michiana, Village of	White Creek	0.030 – 0.050	0.030 – 0.160
New Buffalo, City of	Galien River	0.030 – 0.035	0.05 – 0.10
New Buffalo, Township of	Galien River	0.035	0.05 – 0.10
Niles, City of	Dowagiac River	0.033 – 0.040	0.05 – 0.10
	St. Joseph River	0.025 – 0.034	0.08 – 0.10
	West Tributary	0.03 – 0.06	0.035 – 0.10
Royalton, Township of	St. Joseph River	0.032 – 0.039	0.040 – 0.120
	Yellow River	0.050 – 0.065	0.03 – 0.16
St. Joseph, City of	Paw Paw River	not published	not published
	St. Joseph River	0.030 – 0.035	not published
St. Joseph, Township of	Hickory Creek	0.045	0.07 – 0.10
	St. Joseph River	0.032 – 0.035	0.06 – 0.12
Sodus, Township of	St. Joseph River	0.04 – 0.12	0.032 – 0.039
Watervliet, City of	Paw Paw River	not published	not published
Watervliet, Township of	Paw Paw River	not published	not published

Water surface profile calculations for the detailed studies were determined using the slope-area method or with known downstream water surface elevations, where the calculations were begun at the water surface elevations at the times of peak flow of the corresponding downstream confluence.

The hydraulic analyses for this study are based only on unobstructed flow. The flood elevations shown on the profiles are considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Brandywine Creek, Lemon Creek and Pipestone Creek were evaluated using approximate methods. Galien River, East Branch Galien River and Judy Lake Drain, upstream of the effective study limits (Township of New Buffalo 1979 FIS and City of New Buffalo 1979 FIS) were also evaluated using approximate methods. The 1-percent-annual-chance flood elevations were determined using HEC-RAS. Cross section data was obtained using a USGS Digital Elevation Model (DEM) of Berrien County and Manning’s “n” values were obtained by field observation and aerial photography.

3.3 Vertical Datum

All FIS Reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD29). With the finalization of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NGVD29. Structure and ground elevations in the community must, therefore, be referenced to NGVD29. It is important to note that adjacent communities may be reference to NAVD88. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities.

For more information on NAVD88, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (FEMA, June 1992), or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address <http://www.ngs.noaa.gov>).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages the State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance flood elevations and delineations of the 1- and 0.2-percent-annual-chance floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Tables, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

In order to provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance

floodplain boundaries have been delineated using the flood elevations determined at each cross section.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of moderate flood hazards (Zone X). In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

Approximate 1-percent-annual-chance floodplain boundaries in some portions of the study area were taken directly from the previous FIRMs, listed in Table 9. Because these communities did not have any streams that were studied in detail, no FIS was produced.

TABLE 12 – Previously Published Approximate Study FIRMs

<u>Community</u>	<u>Effective Date</u>
Berrien Springs, Village of	April 30, 1986
Berrien, Township of	August 16, 1988
Buchanan, Township of	March 2, 1998
Coloma, City of	January 18, 1980
Niles, Township of	June 3, 1986
Oronoko, Township of	June 17, 1986
Shoreham, Village of	February 26, 1982
Stevensville, Village of	September 26, 1975

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum standards of FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

In Michigan, under the State's Floodplain Regulatory Authority, found in Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994, PA 451, as amended (Reference 51), encroachment in the floodplain is limited to that which will cause only insignificant increases in flood heights. At the recommendation of the Michigan Department of Environmental Quality, Land and Water Management Division, a floodway having no more than a 0.1-foot surcharge has been delineated for this FIS.

The floodways presented in this FIS report and on the FIRMs were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections (Table 10). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water surface elevation of the 1-percent-annual-chance flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

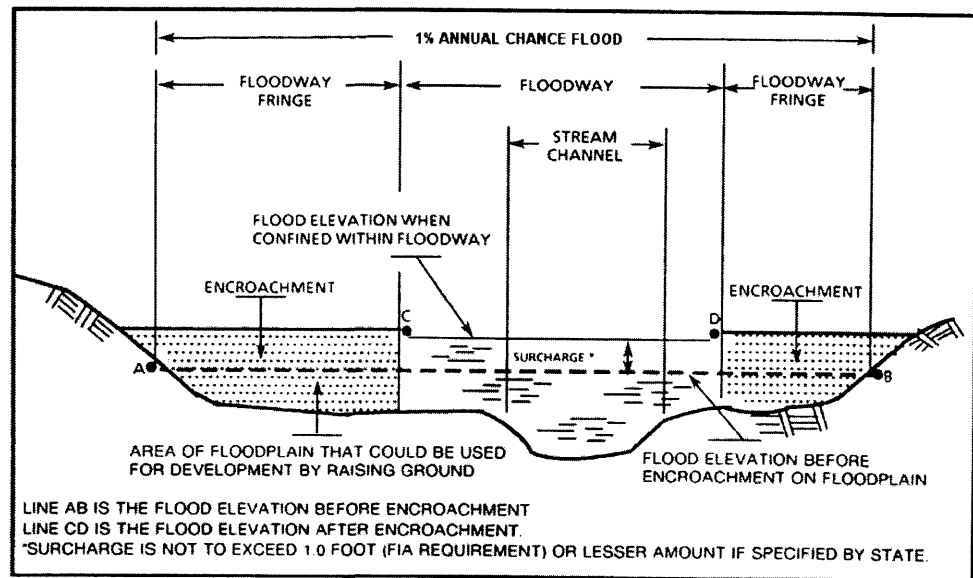


FIGURE 1 – Floodway Schematic

In the areas where the floodway was redelineated, the width of the floodway may have been reduced due to different topographic data. In cases where the floodway width is different than was published in the previous FIS report, the new width is recorded in the Floodway Data Tables (Table 10).

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or used as a basis for additional studies.

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	500	70	291	0.6		617.4	617.4	617.4	0.0
B	679	8	186	2.4		617.4	617.4	617.4	0.0
C	842	49	214	0.8		618.5	618.5	618.5	0.0
D	1,666	26	277	0.6		627.5	627.5	627.5	0.0
E	2,162	180	1,129	0.2		627.5	627.5	627.5	0.0
F	2,662	105	321	0.4		627.5	627.5	627.5	0.0
G	4,162	19	48	2.5		628.0	628.0	628.0	0.0
H	5,287	17	39	2.8		630.1	630.1	630.1	0.0
I	5,811	201	300	0.3		632.2	632.2	632.3	0.1
J	6,107	49	70	1.4		632.3	632.3	632.4	0.1
K	6,733	45	242	0.2		637.2	637.2	637.3	0.1
Feet above confluence with Tanner Creek									
TABLE 13		FEDERAL EMERGENCY MANAGEMENT AGENCY				FLOODWAY DATA			
BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)						BEDORTHA DRAIN			

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	450	27	136	0.9		627.5	627.5	627.5	0.0
B	568	106	286	0.4		628.8	628.8	628.8	0.0
C	1,812	25	40	3.0		633.0	633.0	633.0	0.0
D	1,932	13	86	0.6		638.4	638.4	638.5	0.0
E	2,626	39	58	2.7		638.8	638.8	638.8	0.0

¹Feet above confluence with Bedortha Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

BRIDGMAN CITY DRAIN

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	0	287	3,671	1.6	8	585.0	580.0 ²	580.0	0.0
B	600	465 ³	1,476	4.0		585.0	580.0 ²	580.0	0.0
C	800	126	973	6.0		585.0	580.0 ²	580.0	0.0
D	1,500	169	1,409	4.1		585.0	580.5 ²	580.5	0.0
E	1,800	200	1,851	1.5		585.0	580.7 ²	580.7	0.0
F	1,910	136	1,316	4.4		585.0	580.7 ²	580.7	0.0
G	1,990	102	749	7.8		585.0	580.7 ²	580.7	0.0
H	2,170	335 ³	2,650	2.2		585.0	582.4 ²	582.4	0.0
I	2,720	585 ³	1,950	3.0		585.0	582.4 ²	582.4	0.0
J	3,620	141	1,221	4.8		585.0	582.8 ²	582.8	0.0
K	4,220	1,437	5,302	1.1		585.0	583.3 ²	583.4	0.1
L	5,120	1,003	3,923	1.5		585.0	583.4 ²	583.5	0.1
M	5,970	1,305	5,860	1.0		585.0	583.6 ²	583.7	0.1
N	6,870	1,805	7,583	0.8		585.0	583.7 ²	583.8	0.1
O	7,850	2,476	9,074	0.7		585.0	583.8 ²	583.9	0.1
P	11,000	1,801	5,774	1.0		585.0	584.1 ²	584.1	0.0
Q	11,950	1,677	5,328	1.1		585.0	584.3 ²	584.4	0.1
R	12,850	1,397	5,254	1.1		585.0	584.4 ²	584.5	0.1
S	14,130	145	1,069	5.6		585.0	584.9 ²	584.9	0.0
T	14,210	104	830	7.3		585.1	585.1	585.1	0.0
U	14,410	85	685	8.8		585.6	585.6	585.7	0.1
V	16,660	898	5,993	1.0		587.8	587.8	587.8	0.0
W	17,910	1,463	8,919	0.7		588.0	588.0	588.0	0.0
X	18,370	1,627	10,021	0.6		588.1	588.0	588.1	0.1
Y	20,490	1,057	7,550	0.8		588.2	588.2	588.2	0.0

¹Feet above confluence with Lake Michigan

²Elevations without considering backwater effect from Lake Michigan

³Width includes areas below the ordinary high water mark

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GALIEN RIVER

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	200	129	567	0.2		609.4	609.4	609.4	0.0
B	900	144	485	0.2		609.4	609.4	609.4	0.0
C	1,900	36	48	2.2		609.7	609.7	609.7	0.0
D	3,100	67	60	1.8		612.2	612.2	612.2	0.0
E	3,900	58	50	2.1		614.5	614.5	614.5	0.0
F	4,400	35	38	2.8		617.0	617.0	617.0	0.0
G	5,050	12	21	5.0		618.8	618.8	618.8	0.0
H	5,100	29	37	1.5		619.3	619.3	619.3	0.0
I	5,400	139	390	0.1		626.4	626.4	626.4	0.0
J	5,850	99	27	2.0		626.4	626.4	626.4	0.0
K	5,950	85	186	0.1		627.5	627.5	627.5	0.0
L	6,350	279	428	0.1		627.5	627.5	627.5	0.0

¹ Feet above confluence with Glenlord Road Drain (South Branch)

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GLENLORD ROAD DRAIN
(NORTH BRANCH)

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	270	90	179	1.2		602.6	602.6	602.6	0.0
B	408	104	362	0.6		605.2	605.2	605.2	0.0
C	572	128	531	0.4		605.2	605.2	605.2	0.0
D	1,476	90	317	0.5		609.4	609.4	609.4	0.0
E	2,376	33	54	2.9		611.1	611.1	611.1	0.0
F	3,076	62	52	3.0		616.1	616.1	616.1	0.0
G	3,676	62	76	2.0		620.9	620.9	620.9	0.0
H	3,801	117	704	0.2		626.4	626.4	626.4	0.0
I	4,301	63	204	0.7		626.4	626.4	626.4	0.0

¹Feet above confluence with Parker/Richardson Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GLENLORD ROAD DRAIN
(SOUTH BRANCH)

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,000	27	27	3.9		606.6	606.6	606.6	0.0
B	1,140	5	39	2.7		612.6	612.6	612.6	0.0
C	1,300	102	492	0.2		612.7	612.7	612.7	0.0
D	1,400	59	168	0.6		612.7	612.7	612.7	0.0
E	1,570	5	28	3.8		613.7	613.7	613.7	0.0
F	1,775	76	153	0.7		614.0	614.0	614.0	0.0
G	2,015	100	1,176	0.1		623.9	623.9	623.9	0.0
H	2,500	147	1,206	0.1		623.9	623.9	623.9	0.0
I	3,350	122	385	0.2		623.9	623.9	623.9	0.0
J	3,850	57	96	0.9		623.9	623.9	623.9	0.0
K	4,050	110	314	0.3		627.5	627.5	627.5	0.0
L	4,600	59	108	0.8		627.5	627.5	627.5	0.0
M	5,200	17	27	3.2		629.4	629.4	629.4	0.0

¹Feet above confluence with Hickory Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GOODROW DRAIN

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	1,000	369	204	0.7		594.2	591.3 ²	591.3	0.0	
B	1,750	128	110	1.3		594.3	594.3	594.3	0.0	
C	2,025	142	130	1.1		595.3	595.3	595.3	0.0	
D	2,110	217	858	0.2		598.1	598.1	598.1	0.0	
E	2,160	174	688	0.2		598.1	598.1	598.1	0.0	
F	3,100	86	87	1.6		599.6	599.6	599.6	0.0	
G	4,200	55	73	1.9		604.9	604.9	604.9	0.0	
H	4,359	4	36	3.9		609.4	609.4	609.4	0.0	
I	6,541	46	41	3.4		618.4	618.4	618.4	0.0	
J	6,716	12	54	2.6		618.8	618.8	618.8	0.0	
K	8,216	11	20	7.0		628.0	628.0	628.0	0.0	
L	9,706	3	17	8.2		638.5	638.5	638.5	0.0	
M	10,006	21	116	1.2		639.3	639.3	639.3	0.0	
N	10,395	80	381	0.4		639.5	639.5	639.5	0.0	
O	12,093	24	54	2.6		640.7	640.7	640.7	0.0	

¹Feet above confluence with Paw Paw River

²Elevation taken without consideration of backwater from Paw Paw River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GRANGER DRAIN

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	300	3	12	4.0		624.6	624.6	624.6	0.0
B	538	2	12	4.0		627.1	627.1	627.1	0.0
C	1,745	36	26	1.7		633.6	633.6	633.6	0.0
D	1,966	3	6	7.2		633.8	633.8	633.8	0.0
E	2,268	4	14	3.1		638.2	638.2	638.2	0.0
F	2,368	17	98	0.4		639.6	639.6	639.6	0.0
G	3,418	20	63	0.7		639.6	639.6	639.6	0.0

Feet above confluence with Granger Drain

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

GRANGER DRAIN TRIBUTARY

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	3,430	106	509	5.3		585.8	585.8	585.8	0.0	
B	3,630	200	1,170	2.3		586.7	586.7	586.7	0.0	
C	4,230	163	448	6.0		586.9	586.9	586.9	0.0	
D	5,180	494	2,647	1.0		588.4	588.4	588.4	0.0	
E	5,880	100	560	4.8		588.4	588.4	588.4	0.0	
F	6,080	204	1,555	1.7		589.2	589.2	589.2	0.0	
G	7,580	524	3,136	0.9		589.4	589.4	589.4	0.0	
H	9,280	131	700	3.8		589.6	589.6	589.6	0.0	
I	9,704	530	3,394	0.8		590.4	590.4	590.4	0.0	
J	11,304	804	3,932	0.7		590.6	590.6	590.6	0.0	
K	12,004	349	1,796	1.4		590.7	590.7	590.8	0.1	
L	13,504	395	1,780	1.5		591.4	591.4	591.4	0.0	
M	15,704	100	432	6.0		593.1	593.1	593.1	0.0	
N	15,835	48	434	6.0		594.2	594.2	594.2	0.0	
O	15,940	145	615	4.2		594.7	594.7	594.7	0.0	
P	16,735	497	2,847	0.9		595.7	595.7	595.7	0.0	
Q	17,935	248	1,395	1.9		596.1	596.1	596.1	0.0	
R	18,535	110	735	3.5		596.4	596.4	596.4	0.0	
S	18,720	46	410	6.3		596.6	596.6	596.6	0.0	
T	19,770	110	756	3.4		597.7	597.7	597.7	0.0	
U	20,170	69	717	3.6		598.5	598.5	598.5	0.0	
V	20,470	450	3,640	0.7		598.8	598.8	598.8	0.0	
W	22,435	726	4,030	0.6		598.9	598.9	598.9	0.0	
X	23,970	80/170 ²	890	2.9		599.1	599.1	599.1	0.0	
Y	24,068	324	1,623	1.6		599.9	599.9	599.9	0.0	
Z	24,943	527	2,442	0.9		600.2	600.2	600.2	0.0	

¹Feet above confluence with St. Joseph River

²Left channel facing downstream / right channel facing downstream

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

HICKORY CREEK

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AA	25,593	83	539	4.0		600.4	600.4	600.4	0.0
AB	25,643	48	422	5.0		600.4	600.4	600.4	0.0
AC	26,873	410	1,932	1.1		601.4	601.4	601.4	0.0
AD	28,073	444	1,304	1.6		601.8	601.8	601.8	0.0
AE	29,073	540	1,967	1.1		602.5	602.5	602.5	0.0
AF	35,233	85	424	5.0		607.3	607.3	607.3	0.0
AG	35,333	45	435	4.9		607.6	607.6	607.6	0.0
AH	36,567	406	1,478	1.4		608.7	608.7	608.7	0.0

¹Feet above confluence with St. Joseph River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

HICKORY CREEK

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	2,000	80	289	3.2		585.0	582.6 ²	582.6	0.0	
B	2,230	15	110	8.4		585.0	582.8 ²	582.8	0.0	
C	3,650	41	244	3.8		585.0	584.8 ²	584.9	0.1	
D	3,844	55	177	5.2		585.3	585.3	585.3	0.0	
E	4,225	68	291	3.2		585.9	585.9	585.9	0.0	
F	4,438	63	241	3.8		586.9	586.9	586.9	0.0	
G	4,521	200	771	1.2		587.7	587.7	587.7	0.0	
H	4,653	288	535	1.7		587.7	587.7	587.7	0.0	
I	5,353	66	339	2.7		588.0	588.0	588.0	0.0	
J	5,484	111	369	2.5		588.6	588.6	588.6	0.0	
K	5,578	174	441	2.1		588.6	588.6	588.6	0.0	
L	5,804	225	568	1.6		588.8	588.8	588.8	0.0	
M	6,353	238	719	1.3		589.0	589.0	589.0	0.0	
N	6,469	226	679	1.4		589.4	589.4	589.4	0.0	
O	7,703	623	2,193	0.4		589.4	589.4	589.4	0.0	
P	9,003	358	867	1.1		589.5	589.5	589.5	0.0	
Q	9,228	388	712	1.3		590.3	590.3	590.3	0.0	
R	9,263	321	1,231	0.8		590.6	590.6	590.6	0.0	
S	9,557	126	461	1.9		590.9	590.9	590.9	0.0	
T	9,657	340	1,763	0.5		591.0	591.0	591.0	0.0	
U	11,157	161	466	1.8		591.2	591.2	591.2	0.0	
V	12,347	26	93	9.2		593.7	593.7	593.7	0.0	
W	12,485	117	306	2.8		597.0	597.0	597.0	0.0	
X	12,907	199	890	1.0		597.6	597.6	597.6	0.0	
Y	12,967	200	967	0.9		597.8	597.8	597.8	0.0	
Z	13,657	292	1,102	0.8		597.8	597.8	597.8	0.0	

¹Feet above confluence with Paw Paw River

²Elevations computed without considering backwater effect from Paw Paw River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

OX CREEK

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AA	13,832	237	989	0.9		597.8	597.8	597.8	0.0
AB	14,957	137	416	2.1		599.6	599.6	599.6	0.0
AC	15,967	200	710	1.2		603.7	603.7	603.7	0.0
AD	16,007	110	583	1.5		603.7	603.7	603.7	0.0
AE	17,207	83	278	3.1		604.6	604.6	604.6	0.0
AF	18,657	42	108	4.5		608.0	608.0	608.0	0.0
AG	18,803	15	65	7.5		608.3	608.3	608.3	0.0
AH	21,143	165	411	1.2		613.3	613.3	613.3	0.0

Feet above confluence with Paw Paw River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

OX CREEK

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	375	151	290	2.5		600.2	600.2	600.2	0.0
B	675	249	987	0.7		600.5	600.5	600.5	0.0
C	1,325	44	179	4.1		600.7	600.7	600.7	0.0
D	1,418	15	152	4.8		601.9	601.9	601.9	0.0
E	1,868	282	1,158	0.6		602.5	602.5	602.5	0.0
F	3,628	73	166	2.8		605.1	605.1	605.1	0.0
G	4,423	233	451	1.1		606.8	606.8	606.8	0.0
H	5,098	168	266	1.6		607.4	607.4	607.4	0.0
I	6,123	198	227	1.8		609.7	609.7	609.7	0.0
J	7,173	128	137	3.0		612.4	612.4	612.4	0.0
K	8,423	248	311	1.3		616.7	616.7	616.7	0.0
L	9,248	20	32	3.4		620.4	620.4	620.4	0.0
M	9,798	13	29	3.8		624.4	624.4	624.4	0.0
N	9,913	4	27	4.1		628.4	628.4	628.4	0.0
O	10,863	16	42	2.6		629.0	629.0	629.0	0.0
P	10,973	5	27	4.1		629.4	629.4	629.4	0.0
Q	12,573	150	198	0.6		631.8	631.8	631.8	0.0

¹ Feet above confluence with Hickory Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

PARKER/RICHARDSON DRAIN

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	0.12	183	2,037	2.0		585.0	583.0 ²	583.0	0.0	
B	0.16	350	3,037	1.4		585.0	583.0 ²	583.0	0.0	
C	0.33	92	1,040	3.9		585.0	583.4 ²	583.4	0.0	
D	0.40	162	1,197	3.4		585.0	583.6 ²	583.6	0.0	
E	0.85	940	3,591	1.9		585.0	584.4 ²	584.4	0.0	
F	0.88	585	1,376	3.0		585.0	584.5 ²	584.5	0.0	
G	1.08	1,085	2,768	1.5		585.0	584.8 ²	584.8	0.0	
H	1.38	595	2,686	1.5		585.3	585.3	585.3	0.0	
I	1.43	160	1,432	2.9		585.5	585.5	585.5	0.0	
J	1.46	250	1,884	2.2		585.5	585.5	585.5	0.0	
K	2.07	110	1,221	3.4		587.3	587.3	587.3	0.0	
L	2.09	115	1,206	3.4		587.3	587.3	587.3	0.0	
M	2.12	98	1,311	3.1		587.7	587.7	587.7	0.0	
N	2.58	1,000	7,481	0.6		587.9	587.9	587.9	0.0	
O	3.04	1,793	12,637	0.3		588.0	588.0	588.0	0.0	
P	4.42	2,035	8,271	0.5		589.0	589.0	589.0	0.0	
Q	6.45	2,500	11,476	0.4		590.0	590.0	590.0	0.0	
R	7.74	1,840	7,239	0.6		591.5	591.5	591.5	0.0	
S	8.92	2,020	8,122	0.5		593.2	593.2	593.2	0.0	
T	9.86	418/160 ³	2,548	1.6		597.1	597.1	597.1	0.0	
U	9.93	131	1,016	4.0		597.5	597.5	597.5	0.0	
V	10.03	1,190	7,180	0.6		598.0	598.0	598.0	0.0	
W	11.26	1,865	8,330	0.5		598.6	598.6	598.6	0.0	
X	11.78	1,695	7,658	0.5		599.0	599.0	599.0	0.0	
Y	11.85	133	724	5.7		600.0	600.0	600.0	0.0	
Z	12.09	820	3,149	1.3		601.2	601.2	601.2	0.0	

¹Miles above confluence with St. Joseph River

²Elevation computed without considering backwater effect from Lake Michigan

³Left overbank / main channel

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

PAW PAW RIVER

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AA	12.11	148	1,462	2.8		601.4	601.4	601.4	0.0
AB	12.14	755	3,473	1.2		601.7	601.7	601.7	0.0
AC	13.14	872	5,148	0.8		603.0	603.0	603.0	0.0
AD	13.92	1,240	6,827	0.6		603.7	603.7	603.7	0.0
AE	14.49	1,100	6,202	0.7		604.1	604.1	604.1	0.0
AF	14.52	576	849	4.8		604.2	604.2	604.2	0.0
AG	14.69	1,690	7,320	0.6		604.6	604.6	604.6	0.0
AH ²	16.08	N/A	N/A	N/A		607.0	N/A	N/A	N/A
AI ²	16.38	N/A	N/A	N/A		607.5	N/A	N/A	N/A
AJ ²	16.70	N/A	N/A	N/A		607.7	N/A	N/A	N/A
AK ²	18.30	N/A	N/A	N/A		609.5	N/A	N/A	N/A
AL ²	18.48	N/A	N/A	N/A		610.2	N/A	N/A	N/A
AM ²	18.51	N/A	N/A	N/A		610.2	N/A	N/A	N/A
AN ²	18.53	N/A	N/A	N/A		611.2	N/A	N/A	N/A
AO ²	18.87	N/A	N/A	N/A		612.0	N/A	N/A	N/A
AP ²	19.40	N/A	N/A	N/A		612.9	N/A	N/A	N/A
AQ ²	19.46	N/A	N/A	N/A		613.7	N/A	N/A	N/A
AR ²	19.65	N/A	N/A	N/A		614.0	N/A	N/A	N/A
AS ²	19.72	N/A	N/A	N/A		614.2	N/A	N/A	N/A
AT ²	19.76	N/A	N/A	N/A		614.4	N/A	N/A	N/A
AU ²	20.00	N/A	N/A	N/A		614.5	N/A	N/A	N/A
AV ²	21.29	N/A	N/A	N/A		617.6	N/A	N/A	N/A
AW ²	22.01	N/A	N/A	N/A		618.4	N/A	N/A	N/A
AX ²	23.83	N/A	N/A	N/A		627.4	N/A	N/A	N/A
AY ²	25.51	N/A	N/A	N/A		628.8	N/A	N/A	N/A
AZ ²	25.89	N/A	N/A	N/A		629.9	N/A	N/A	N/A

¹Miles above confluence with St. Joseph River

²No floodway data computed

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

PAW PAW RIVER

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BA ²	26.57	N/A	N/A	N/A		630.3	N/A	N/A	N/A
BB ²	27.88	N/A	N/A	N/A		633.4	N/A	N/A	N/A

¹Miles above confluence with St. Joseph River

²No floodway data computed

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

PAW PAW RIVER

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	0.40	255	6,713	3.6		585.0	581.0 ³	581.0	0.0	
B	0.46	255	6,629	3.6		585.0	581.0 ³	581.0	0.0	
C	0.57	390	8,417	2.9		585.0	581.1 ³	581.1	0.0	
D	0.62	411	6,816	3.5		585.0	581.1 ³	581.1	0.0	
E	0.65	350	8,633	2.8		585.0	581.2 ³	581.2	0.0	
F	0.72	315	7,645	3.1		585.0	581.2 ³	581.2	0.0	
G	0.82	383	7,863	3.1		585.0	581.2 ³	581.2	0.0	
H	0.87	391	6,381	3.8		585.0	581.2 ³	581.2	0.0	
I	0.91	450	7,832	3.1		585.0	581.3 ³	581.3	0.0	
J	1.19	382 ²	6,955	3.3		585.0	581.5 ³	581.5	0.0	
K	1.23	462 ²	7,684	3.0		585.0	581.5 ³	581.5	0.0	
L	1.26	490 ²	5,620	4.1		585.0	581.5 ³	581.5	0.0	
M	1.77	800 ²	7,517	3.1		585.0	582.2 ³	582.2	0.0	
N	2.11	709 ²	6,443	3.6		585.0	582.6 ³	582.6	0.0	
O	2.42	718 ²	6,953	3.3		585.0	583.1 ³	583.1	0.0	
P	2.69	823 ²	7,596	3.1		585.0	583.4 ³	583.4	0.0	
Q	2.99	431	5,391	4.3		585.0	583.8 ³	583.8	0.0	
R	3.04	445	5,061	4.6		585.0	583.8 ³	583.8	0.0	
S	3.43	878	6,485	3.6		585.0	584.7 ³	584.7	0.0	
T	3.90	974	6,847	3.4		585.6	585.6	585.6	0.0	
U	4.26	961	6,502	3.6		586.2	586.2	586.2	0.0	
V	4.89	1,273	7,950	2.9		587.4	587.4	587.5	0.1	
W	5.42	2,920	14,171	1.6		588.1	588.1	588.1	0.0	
X	5.64	1,688	6,920	3.4		588.2	588.2	588.2	0.0	
Y	6.00	750	6,537	3.6		588.9	588.9	588.9	0.0	
Z	6.10	527	6,785	3.4		589.0	589.0	589.0	0.0	

¹Miles above confluence with Lake Michigan

²Width includes floodway of both St. Joseph River and Morrison Channel excluding Radio Island

³Water surface elevations determined without consideration of Lake Michigan backwater

FEDERAL EMERGENCY MANAGEMENT AGENCY		FLOODWAY DATA	
BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)		ST. JOSEPH RIVER	

TABLE 13

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
AA	6.56	355	5,733	4.1	71	589.5	589.5	589.5	0.0	
AB	6.70	360	5,138	4.5	1,527	589.6	589.6	589.6	0.0	
AC	6.90	2,284	14,641	1.6		590.0	590.0	590.0	0.0	
AD	7.21	2,043	14,874	1.6		590.2	590.2	590.2	0.0	
AE	7.72	743	5,681	3.9		591.0	591.0	591.0	0.0	
AF	7.93	620	5,998	3.6		591.2	591.2	591.2	0.0	
AG	7.95	618	6,006	3.6		591.3	591.3	591.3	0.0	
AH	8.24	397	5,335	4.0		591.7	591.7	591.7	0.0	
AI	8.35	367	5,344	4.0		591.8	591.8	591.8	0.0	
AJ	8.55	237	3,198	6.7		592.0	592.0	592.0	0.0	
AK	8.56	535	6,052	3.5		592.8	592.8	592.8	0.0	
AL	9.41	935	8,798	2.6		593.4	593.4	593.4	0.0	
AM	9.80	887	6,327	3.6		593.7	593.7	593.7	0.0	
AN	10.35	702	7,478	3.1		594.4	594.4	594.4	0.0	
AO	10.88	997	7,685	3.0		594.9	594.9	594.9	0.0	
AP	11.07	1,266	9,927	2.3		595.1	595.1	595.1	0.0	
AQ	11.33	1,239	8,011	2.6		595.3	595.3	595.3	0.0	
AR	11.64	1,751	10,664	2.2		595.5	595.5	595.5	0.0	
AS	12.08	1,749	12,769	1.8	595.9	595.9	595.9	0.0		
AT	12.57	3,710	19,651	1.2	596.2	596.2	596.2	0.0		
AU	13.19	4,752	20,708	1.1	596.5	596.5	596.5	0.0		
AV	13.90	2,883	15,839	1.5	596.9	596.9	596.9	0.0		
AW	14.37	2,019	12,615	1.8	597.2	597.2	597.2	0.0		
AX	14.88	4,589	25,638	0.9	597.6	597.6	597.6	0.0		
AY	15.16	3,992	14,542	1.6	597.7	597.7	597.7	0.0		
AZ	15.72	3,214	15,839	1.5	598.4	598.4	598.4	0.0		

Miles above confluence with Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

ST. JOSEPH RIVER

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
BA	16.29	1,709	9,558	2.4		599.1	599.1	599.1	0.0	
BB	16.53	1,886	7,581	3.0		599.4	599.4	599.4	0.0	
BC	16.79	2,209	7,619	3.0		599.8	599.8	599.8	0.0	
BD	17.02	1,800	11,035	2.1		600.4	600.4	600.4	0.0	
BE	17.51	1,548	7,143	3.2		600.8	600.8	600.8	0.0	
BF	18.09	1,343	9,272	2.5		601.8	601.8	601.8	0.0	
BG	18.59	1,894	8,488	2.7		602.6	602.6	602.6	0.0	
BH	18.87	2,545	11,006	2.1		603.2	603.2	603.2	0.0	
BI	19.22	2,400	16,686	1.4		603.7	603.7	603.7	0.0	
BJ	20.08	1,145	8,287	2.8		604.5	604.5	604.5	0.0	
BK	40.88	315	3,217	6.8		644.3	644.3	644.3	0.0	
BL	41.24	561	5,281	4.2		646.1	646.1	646.2	0.1	
BM	41.45	258	3,996	5.5		646.4	646.4	646.5	0.1	
BN	41.57	374	3,596	6.1		646.8	646.8	646.9	0.1	
BO	41.68	315	4,328	5.1		647.4	647.4	647.5	0.1	
BP	41.88	322	3,195	6.9		647.9	647.9	648.0	0.1	
BQ	41.97	324	4,680	4.7		648.7	648.7	648.8	0.1	
BR	42.07	296	3,716	5.9		648.8	648.8	648.9	0.1	
BS	42.16	301	4,431	5.0		649.2	649.2	649.3	0.1	
BT	42.23	331	4,831	4.6		649.3	649.3	649.4	0.1	
BU	42.43	622	7,460	2.9		649.8	649.8	649.9	0.1	
BV	42.64	416	6,059	3.6		649.9	649.9	649.9	0.0	
BW	42.78	324	4,600	4.8		649.9	649.9	649.9	0.0	
BX	42.89	320	7,163	3.1		659.8	659.8	659.8	0.0	
BY	42.96	357	5,859	3.8		659.8	659.8	659.8	0.0	
BZ	43.08	457	5,687	3.9		659.9	659.9	659.9	0.0	

Miles above confluence with Lake Michigan

¹ Miles above confluence with Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

ST. JOSEPH RIVER

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	1,550	720	2,571	0.4		590.3	590.3	590.4	0.1	
B	5,250	375	1,244	1.1		591.6	591.6	591.6	0.0	
C	5,310	305	389	3.7		591.7	591.7	591.7	0.0	
D	6,620	721	2,523	0.7		592.9	592.9	592.9	0.0	
E	6,720	637	2,017	0.9		592.9	592.9	592.9	0.0	
F	7,090	620	2,034	0.9		593.1	593.1	593.1	0.0	

¹ Feet above limit of detailed study (limit of detailed study is 5,300 feet downstream of Bacon Road)

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

ST. JOSEPH RIVER (LEFT OVERBANK)

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Tanner Creek									
A	400	28	95	3.8		586.3	586.3	586.3	0.0
B	1,350	27	101	3.6		591.0	591.0	590.7	0.0
C	2,370	29	103	3.5		594.6	594.6	594.6	0.0
D	2,750	59	178	2.0		597.1	597.1	597.1	0.0
E	3,221	22	96	3.8		597.8	597.8	597.8	0.0
F	3,543	23	78	4.6		598.6	598.6	598.6	0.0
G	4,239	135	794	0.5		607.7	607.7	607.8	0.1
H	4,389	145	399	0.9		607.7	607.7	607.8	0.1
I	4,710	32	228	1.6		607.8	607.8	607.9	0.1
J	4,818	31	277	1.9		607.8	607.8	607.9	0.1
K	5,077	86	505	0.7		610.9	610.9	610.9	0.0
L	5,221	21	264	1.9		610.9	610.9	610.9	0.0
M	5,658	56	484	0.7		617.4	617.4	617.4	0.0
William & Esseg Drain									
N	6,183	230	422	0.4		617.4	617.4	617.4	0.0
O	6,222	193	329	0.7		617.4	617.4	617.4	0.0
P	6,881	23	94	1.9		618.9	618.9	618.9	0.0
Q	6,925	23	97	1.9		619.0	619.0	619.0	0.0
R	7,763	22	41	4.4		624.8	624.8	624.8	0.0
S	8,213	123	475	0.4		625.9	625.9	626.0	0.0
T	8,358	15	48	3.8		625.9	625.9	625.9	0.0
U	8,731	175	693	0.1		628.5	628.5	628.6	0.0
V	9,306	16	50	4.3		628.4	628.4	628.4	0.0
W	9,672	126	48	1.9		630.2	630.2	630.2	0.0

¹ Feet above confluence with Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

TANNER CREEK, WILLIAM & ESSEG DRAIN

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	500	19	36	6.1		585.0	585.0	585.0	0.0	
B	1,150	22	46	4.8		589.3	589.3	589.3	0.0	
C	1,700	22	43	5.1		592.7	592.7	592.7	0.0	
D	1,825	24	56	3.9		593.7	593.7	593.7	0.0	
E	2,476	25	55	4.0		597.2	597.2	597.2	0.0	
F	3,076	72	53	4.2		602.3	602.3	602.3	0.0	
G	3,162	70	204	1.1		605.0	605.0	605.0	0.0	
H	3,488	36	60	3.2		605.3	605.3	605.3	0.0	
I	3,578	10	49	4.0		606.3	606.3	606.3	0.0	
J	4,229	35	47	4.1		606.9	606.9	606.9	0.0	
K	4,282	15	43	4.2		607.3	607.3	607.3	0.0	
L	4,608	16	38	4.5		608.1	608.1	608.1	0.0	
M	4,716	5	28	6.1		610.4	610.4	610.4	0.0	
N	5,562	17	36	4.4		613.6	613.6	613.6	0.0	
O	5,679	7	32	5.0		614.0	614.0	614.0	0.0	
P	5,925	24	50	3.2		614.8	614.8	614.8	0.0	
Q	6,069	6	25	6.0		617.2	617.2	617.2	0.0	
R	6,970	20	33	4.2		619.1	619.1	619.1	0.0	
Feet above confluence with Lake Michigan										
FEDERAL EMERGENCY MANAGEMENT AGENCY					FLOODWAY DATA					
BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)					TRIBUTARY A					
TABLE 13										

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	250	25	28	6.1		585.0	582.9 ²	582.9	0.0
B	1,650	16	39	4.4		588.8	588.8	588.8	0.0
C	1,745	6	25	6.8		591.2	591.2	591.2	0.0
D	2,145	153	266	0.4		592.2	592.2	592.2	0.0
E	2,445	16	24	5.0		592.8	592.8	592.8	0.0
F	2,678	7	22	5.0		594.1	594.1	594.1	0.0
G	3,678	19	29	3.8		597.9	597.9	597.9	0.0
H	4,928	21	33	3.3		603.1	603.1	603.1	0.0

¹ Feet above confluence with Lake Michigan

² Elevations taken without consideration of backwater from Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

TRIBUTARY B

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	14	4	10	5.6		592.2	592.2	592.2	0.0
B	89	54	70	0.8		592.9	592.9	592.9	0.0
C	539	16	18	3.1		595.4	595.4	595.4	0.0
D	647	3	13	4.3		600.5	600.5	600.5	0.0
E	872	23	15	3.7		603.5	603.5	603.5	0.0
F	962	64	281	0.2		615.6	615.6	615.6	0.0
G	1,437	122	1,018	0.1		615.6	615.6	615.6	0.0
H	1,937	69	368	0.2		615.6	615.6	615.6	0.0
I	2,043	78	302	0.2		615.6	615.6	615.6	0.0
J	2,518	63	187	0.3		615.6	615.6	615.6	0.0

¹Feet above confluence with Tributary B

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

TRIBUTARY C

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	245	17	39	1.4		589.7	589.7	589.7	0.0	
B	458	3	9	5.8		596.0	596.0	596.0	0.0	
C	780	32	131	0.4		604.2	604.2	604.2	0.0	
D	805	31	132	0.4		604.2	604.2	604.2	0.0	
E	1,116	25	114	0.5		609.6	609.6	609.6	0.0	
F	1,166	28	118	0.5		609.6	609.6	609.6	0.0	
G	1,716	13	36	1.4		609.6	609.6	609.6	0.0	
H	2,416	11	21	2.4		611.6	611.6	611.6	0.0	

¹Feet above confluence with Lake Michigan

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

WHITE CREEK - EAST BRANCH

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	2,819	113	325	1.9		597.9	597.9	597.9	0.0
B	3,940	12 ²	69	8.7		598.8	598.8	598.8	0.0
C	4,010	73	268	2.2		600.3	600.3	600.3	0.0
D	4,935	54	250	2.4		601.0	601.0	601.0	0.0
¹ Feet above confluence with Lake Michigan ² Floodway not shown; contained in culvert									
BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)						FLOODWAY DATA			
FEDERAL EMERGENCY MANAGEMENT AGENCY						WHITE CREEK - WEST BRANCH			
TABLE 13									

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE	
A	1,050	250	804	1.6		589.9	588.4 ²	588.4	0.0	
B	1,875	63	275	4.6		591.0	591.0	591.0	0.0	
C	1,950	23	145	8.8		591.1	591.1	591.1	0.0	
D	4,000	213	679	1.8		594.9	594.9	594.9	0.0	
E	5,650	162	403	2.9		596.4	596.4	596.4	0.0	
F	5,900	29	194	6.1		597.3	597.3	597.3	0.0	
G	7,100	100	438	2.6		599.4	599.4	599.4	0.0	
H	7,150	69	278	4.1		599.5	599.5	599.5	0.0	
I	8,050	384	796	1.4		601.8	601.8	601.8	0.0	
J	9,150	263	427	2.3		603.7	603.7	603.7	0.0	
K	10,850	149	330	3.0		607.5	607.5	607.5	0.0	
L	11,850	70	354	2.4		609.9	609.9	609.9	0.0	
M	11,950	17	142	6.1		610.2	610.2	610.2	0.0	
N	13,500	41	191	3.6		613.9	613.9	613.9	0.0	
O	14,250	177	370	1.9		616.0	616.0	616.0	0.0	
P	15,149	17	120	4.8		617.6	617.6	617.6	0.0	
Q	15,850	12	73	7.8		619.3	619.3	619.3	0.0	
R	16,000	37	181	2.5		620.4	620.4	620.4	0.0	
S	16,050	15	115	3.9		620.4	620.4	620.4	0.0	
T	16,312	171	267	1.7		621.0	621.0	621.0	0.0	
U	16,372	173	237	1.9		621.0	621.0	621.0	0.0	
V	16,424	124	260	1.7		621.4	621.4	621.4	0.0	
W	16,464	117	252	1.8		621.4	621.4	621.4	0.0	
X	16,715	72	271	1.7		621.7	621.7	621.7	0.0	
Y	16,800	29	164	2.7		621.7	621.7	621.7	0.0	
Z	16,925	154	296	1.5		622.2	622.2	622.2	0.0	

¹Feet above confluence with St. Joseph River

²Water surface elevations without considering St. Joseph River backwater

TABLE 13	FEDERAL EMERGENCY MANAGEMENT AGENCY	FLOODWAY DATA
	BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)	
	YELLOW CREEK	

¹Feet above confluence with St. Joseph River

²Water surface elevations without considering St. Joseph River backwater

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERRIEN COUNTY, MICHIGAN
(ALL JURISDICTIONS)

FLOODWAY DATA

YELLOW CREEK

FLOODING SOURCE		FLOODWAY					1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NGVD)		
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH REDUCED FROM PRIOR STUDY (FEET)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AA	18,150	45	159	2.8		624.1	624.1	624.1	0.0
AB	18,200	21	106	4.3		624.1	624.1	624.1	0.0
AC	18,450	39	152	3.0		625.4	625.4	625.4	0.0
AD	18,600	19	122	3.7		625.7	625.7	625.7	0.0
AE	20,000	42	169	2.7		629.3	629.3	629.3	0.0
Feet above confluence with St. Joseph River									
TABLE 13		FEDERAL EMERGENCY MANAGEMENT AGENCY BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)					FLOODWAY DATA		
							YELLOW CREEK		

5.0 INSURANCE APPLICATION

5.1 Flood Insurance Zones

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or base flood depths are shown within this zone.

Zone AE

Zone AE is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone V

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone X

Zone X is the flood insurance risk zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The DFIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the maps designate flood insurance risk zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, the 1-percent-annual-chance fully

developed floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current Flood Insurance Rate Map presents flooding information for the geographic area of Berrien County. Historical data relating to the maps prepared for each community are presented in Table 11, Community Map History.

7.0 OTHER STUDIES

This 2006 FIS incorporates all previously published FISs and FIRMs for the incorporated and unincorporated areas within Berrien County. It also incorporates a 2004 study for the City of Bridgman.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

COMMUNITY MAP HISTORY				
FEDERAL EMERGENCY MANAGEMENT AGENCY		BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)		
TABLE 14				
COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	EFFECTIVE FIRM DATE	FIRM REVISIONS DATE
Bainbridge, Township of	N/A	N/A	N/A	N/A
Baroda, Township of	N/A	N/A	N/A	N/A
Baroda, Village of	N/A	N/A	N/A	N/A
Benton, Township of	June 28, 1974 March 5, 1976	None	April 3, 1978	None
Benton Harbor, City of	May 24, 1974	None	May 15, 1978	None
Berrien Springs, Village of	August 1, 1975	None	April 30, 1986	None
Berrien, Township of	August 16, 1988	None	August 16, 1988	None
Bertrand, Township of	N/A	N/A	N/A	N/A
Bridgman, City of	June 7, 1974	None	November 15, 1979	None
Buchanan, City of	October 24, 1975	None	April 16, 1993	None
Buchanan, Township of	October 8, 1976	None	March 2, 1998	None
Chikaming, Township of	June 28, 1974	None	June 1, 1978	None
Coloma, City of	June 3, 1977	None	January 18, 1980	None
Coloma, Township of	June 28, 1974	March 5, 1976	February 15, 1984	None
Eau Claire, Village of	N/A	N/A	N/A	N/A
Galien, Township of	N/A	N/A	N/A	N/A

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	EFFECTIVE FIRM DATE	FIRM REVISIONS DATE
Galien, Village of	N/A	N/A	N/A	N/A
Grand Beach, Village of	June 28, 1974	None	February 15, 1978	None
Hager, Township of	May 31, 1974	None	December 1, 1977	None
	March 5, 1976			
Lake, Township of	June 28, 1974	October 1, 1976	November 1, 1979	None
Lincoln, Township of	July 26, 1974	None	March 1, 1978	None
Michiana, Village of	June 14, 1974	None	May 1, 1978	None
New Buffalo, City of	May 31, 1974	June 11, 1976	December 4, 1979	None
New Buffalo, Township of	July 26, 1974	September 24, 1976	December 4, 1979	None
Niles, City of	May 31, 1974	June 25, 1976	July 16, 1987	None
Niles, Township of	June 21, 1974	June 18, 1976	June 3, 1986	None
Oronoko, Township of	August 2, 1974	August 6, 1976	June 17, 1986	None
Pipestone, Township of	N/A	N/A	N/A	N/A
Royalton, Township of	June 21, 1974	None	December 1, 1977	None
	June 25, 1976			
St. Joseph, City of	May 24, 1974	None	February 1, 1978	None
St. Joseph, Township of	July 30, 1976	None	June 18, 1980	None

FEDERAL EMERGENCY MANAGEMENT AGENCY	COMMUNITY MAP HISTORY
BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)	

TABLE 14

COMMUNITY MAP HISTORY				
FEDERAL EMERGENCY MANAGEMENT AGENCY		BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)		
COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	EFFECTIVE FIRM DATE	FIRM REVISIONS DATE
Shoreham, Village of	June 21, 1974	June 18, 1976	February 26, 1982	None
Sodus, Township of	August 2, 1974	None	April 3, 1978	None
Stevensville, Village of	September 26, 1975	None	April 17, 2006	None
Three Oaks, Township of	N/A	N/A	N/A	N/A
Three Oaks, Village of	N/A	N/A	N/A	N/A
Watervliet, City of	May 31, 1974	June 11, 1976	November 16, 1983	None
Watervliet, Township of	November 12, 1976	None	November 16, 1983	None
Weesaw, Township of	N/A	N/A	N/A	N/A

FEDERAL EMERGENCY MANAGEMENT AGENCY		BERRIEN COUNTY, MICHIGAN (ALL JURISDICTIONS)		
TABLE 14				

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive (24th Floor), Chicago, Illinois 60606.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency, Flood Insurance Study, Township of Benton, Berrien County, Michigan, Washington, D.C. report dated June 1977, rate map dated April 3, 1978
2. Federal Emergency Management Agency, Flood Insurance Study, City of Benton Harbor, Berrien County, Michigan, Washington, D.C. report dated November 1977, rate map dated May 15, 1978.
3. Federal Emergency Management Agency, Flood Insurance Rate Map, Village of Berrien Springs, Berrien County, Michigan, Washington, D.C. April 30, 1986.
4. Federal Emergency Management Agency, Flood Insurance Rate Map, Township of Berrien, Berrien County, Michigan, Washington, D.C. August 16, 1988.
5. Federal Emergency Management Agency, Flood Insurance Study, City of Bridgman, Berrien County, Michigan, Washington, D.C. report dated August 2004.
6. Federal Emergency Management Agency, Flood Insurance Study, City of Bridgman, Berrien County, Michigan, Washington, D.C. report dated May 1979, rate map dated November 15, 1979.
7. Federal Emergency Management Agency, Flood Insurance Study, City of Buchanan, Berrien County, Michigan, Washington, D.C. report dated April 16, 1993, rate map dated April 16, 1993.
8. Federal Emergency Management Agency, Flood Insurance Rate Map, Township of Buchanan, Berrien County, Michigan, Washington, D.C. March 2, 1998.
9. Federal Emergency Management Agency, Flood Insurance Study, Township of Chikaming, Berrien County, Michigan, Washington, D.C. report dated August 15, 1983, rate map dated June 1, 1978.
10. Federal Emergency Management Agency, Flood Insurance Rate Map, City of Coloma, Berrien County, Michigan, Washington, D.C. January 18, 1980.
11. Federal Emergency Management Agency, Flood Insurance Study, Township of Coloma, Berrien County, Michigan, Washington, D.C. report dated December 1977, rate map dated February 15, 1984.

12. Federal Emergency Management Agency, Flood Insurance Study, Village of Grand Beach, Berrien County, Michigan, Washington, D.C. report dated April 1977, rate map dated February 15, 1978.
13. Federal Emergency Management Agency, Flood Insurance Study, Township of Hager, Berrien County, Michigan, Washington, D.C. report dated February 1977, rate map dated December 1, 1977.
14. Federal Emergency Management Agency, Flood Insurance Study, Township of Lake, Berrien County, Michigan, Washington, D.C. report dated May 1979, rate map dated November 1, 1979.
15. Federal Emergency Management Agency, Flood Insurance Study, Township of Lincoln, Berrien County, Michigan, Washington, D.C. report dated May 1977, rate map dated March 1, 1978.
16. Federal Emergency Management Agency, Flood Insurance Study, Village of Michiana, Berrien County, Michigan, Washington, D.C. report dated November 1977, rate map dated May 1, 1978.
17. Federal Emergency Management Agency, Flood Insurance Study, City of New Buffalo, Berrien County, Michigan, Washington, D.C. report dated June 1979, rate map dated December 4, 1979.
18. Federal Emergency Management Agency, Flood Insurance Study, Township of New Buffalo, Berrien County, Michigan, Washington, D.C. report dated June 1979, rate map dated December 4, 1979.
19. Federal Emergency Management Agency, Flood Insurance Study, City of Niles, Berrien County, Michigan, Washington, D.C. report dated July 16, 1987, rate map dated July 16, 1987.
20. Federal Emergency Management Agency, Flood Insurance Rate Map, Township of Niles, Berrien County, Michigan, Washington, D.C. June 3, 1986.
21. Federal Emergency Management Agency, Flood Insurance Rate Map, Township of Oronoko, Berrien County, Michigan, Washington, D.C. June 17, 1986.
22. Federal Emergency Management Agency, Flood Insurance Study, Township of Royalton, Berrien County, Michigan, Washington, D.C. report dated February 1977, rate map dated December 1, 1977.
23. Federal Emergency Management Agency, Flood Insurance Study, City of St. Joseph, Berrien County, Michigan, Washington, D.C. report dated December 1976, rate map dated February 1, 1978.
24. Federal Emergency Management Agency, Flood Insurance Study, Township of St. Joseph, Berrien County, Michigan, Washington, D.C. report dated December 1979, rate map dated June 18, 1980.

25. Federal Emergency Management Agency, Flood Insurance Rate Map, Village of Shoreham, Berrien County, Michigan, Washington, D.C. February 26, 1982.
26. Federal Emergency Management Agency, Flood Insurance Study, Township of Sodus, Berrien County, Michigan, Washington, D.C. report dated June 1977, rate map dated April 3, 1978.
27. Federal Emergency Management Agency, Flood Insurance Rate Map, Village of Stevensville, Berrien County, Michigan, Washington, D.C. September 26, 1975.
28. Federal Emergency Management Agency, Flood Insurance Study, City of Watervliet, Berrien County, Michigan, Washington, D.C. report dated May 16, 1983, rate map dated November 16, 1983.
29. Federal Emergency Management Agency, Flood Insurance Study, Township of Watervliet, Berrien County, Michigan, Washington, D.C. report dated May 16, 1983, rate map dated November 16, 1983.
30. U.S. Department of Commerce, U.S. Census Bureau, (n.d.). April 1, 2000 Census Population; July 1, 2003 Population Estimate. Retrieved May 14, 2004, from www.census.gov/
31. Michigan State Climatologist's Office, Eau Claire (Station 2445). Retrieved May 17, 2004, from <http://climate.geo.msu.edu/>
32. U.S. Army Corps of Engineers, Report No. 308, Water Resources and Development in the St. Joseph River Basin, 1933.
33. U.S. Army Corps of Engineers, Detroit District, Survey Report on Flood Control of St. Joseph River Basin, Michigan and Indiana, March 1971.
34. Great Lakes Basin Commission, Great Lakes Framework Study, Appendix 11, Levels and Flows, 1975.
35. U.S. Army Corps of Engineers for FEMA. Phase I - Revised Report on Great Lakes Open-Coast Flood Levels. Detroit, MI. April 1988.
36. USGS Peak Streamflow gages for the Nation. Retrieved May 17, 2004, from <http://nwis.waterdata.usgs.gov/usa/nwis/peak>
37. Sorrell, Richard C., Computing Flood Discharges for Small Ungaged Watersheds, Michigan Department of Environmental Quality, July 2003.
38. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-HMS Hydrologic Modeling System, Davis, California, 1998.
39. Huff, Floyd A. and Angel, James R., Bulletin 71, Rainfall Frequency Atlas of the Midwest, Midwestern Climate Center research report 92.03, 992

40. U.S. Geological Survey, 7.5 Minute Series Topographical Maps, Scale 1:24000, Contour Interval ten feet: Bridgman Quadrangle, Berrien County, Michigan, (Photorevised) 1973.
41. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Berrien County, Michigan, 1980.
42. Environmental Systems Research Institute, Inc., ArcView GIS, Redlands, California, 1999.
43. Soil Conservation Service, Technical Release No. 20, Computer Program for Project Formulation, Hydrology, May 1965.
44. Soil Conservation Service, "Hydrology," National Engineering Handbook, Section 4, August 1972.
45. Soil Conservation Service, Engineering Division, Technical Release No. 55, Urban Hydrology for Small Watersheds, January 1975.
46. U.S. Geological Survey, Michigan Department of Natural Resources, Water Investigations Report 84-4207, Statistical Models for Estimating Flow Characteristics of Michigan Streams, Lansing, Michigan, 1984.
47. U.S. Army Corps of Engineers, Hydraulic Engineering Center, HEC-RAS River Analysis System, Davis, California, 1998.
48. U.S. Army Corps of Engineers, Paw Paw Lake Final Detailed Project Report and Final Environmental Impact Statement, Section 205, November 1983.
49. U.S. Army Corps of Engineers, Hydraulic Engineering Center, HEC-2 Water Surface Profiles, various dates.
50. Soil Conservation Service (NRCS), Technical Release 61 – WSP2 Water Surface Profile Computations, various dates.
51. Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA).